EXHIBIT G

IN THE UNITED STATES DISTRICT COURT
FOR THE WESTERN DISTRICT OF TEXAS
WACO DIVISION

ALIGN TECHNOLOGY, INC., Plaintiff, v. CLEARCORRECT OPERATING, LLC, CLEARCORRECT HOLDINGS, INC., & INSTITUT STRAUMANN AG, Defendants.	Civil Action No. 6:24-cv-00187-ADA-DTG JURY TRIAL DEMANDED
CLEARCORRECT OPERATING, LLC, CLEARCORRECT HOLDINGS, INC., & STRAUMANN USA, LLC, Counterclaim-Plaintiffs, v. ALIGN TECHNOLOGY, INC., Counterclaim-Defendant.	

DECLARATION OF ZIXIANG XIONG, PH.D. IN SUPPORT OF CLEARCORRECT'S OPENING CLAIM CONSTRUCTION BRIEF

I. INTRODUCTION

1. I have been retained by ClearCorrect Operating LLC, ClearCorrect Holdings, Inc., and Institut Straumann AG (collectively, "ClearCorrect") to provide my expert analysis in this matter.

2. I understand that Align Technology, Inc. ("Align ") has accused ClearCorrect of infringing certain claims in U.S. Patent Nos. 8,038,444 (the "'444 patent"), 10,456,217 (the "'217 patent"), 10,524,879 (the "'879 patent"), 11,369,456 (the "'456 patent") (collectively, the "Treatment Planning Patents"), and 10,791,936 (the "'936 patent") (collectively, the "Asserted Patents").

3. I am being compensated for my time at $850 an hour, which is my standard consulting rate. My compensation is not dependent on the conclusions expressed in this Declaration or the outcome of this matter.

4. I have been asked for my conclusions concerning the proper construction of certain disputed claim terms in the Treatment planning Patents. I have reviewed those patents and their prosecution histories, and the parties' Disclosure of Preliminary Claim Constructions.

II. QUALIFICATIONS

5. Currently, I am a full professor and associate head of the Electrical and Computer Engineering Department at Texas A&M University. I am also the Director of the Multimedia Laboratory at Texas A&M. I have been with Texas A&M for 25 years.

6. I received a Bachelor of Science degree in Electrical Engineering from Wuhan University, China in 1987. I was a Master of Science student at the University of the Chinese Academy of Sciences between September 1987 and December 1989. I came to the United States in January of 1990 to further my education. I received a Master of Arts degree in Mathematics from the University of Kansas in 1991, a Master of Science degree in Electrical Engineering from

the Illinois Institute of Technology in 1992, and the Doctor of Philosophy (Ph.D.) degree in Electrical Engineering in 1996 from the University of Illinois at Urbana-Champaign. In the fall of 1995, I followed my Ph.D. adviser to Princeton University, first as a visiting student (1995-1996), then as a research associate (1996-1997).

7. I have nearly 40 years of R&D experience on image/video processing & coding, multimedia communications, pattern recognition, and computer vision. I have published 11 book chapters, 152 journal articles and 249 conference papers. I am also listed as an inventor on 23 patents.

8. I am well experienced with reading and writing software code and software algorithms. For example, I have extensive source code (C/C++ & Verilog) review experience. I have also written sophisticated image/video compression software in C/C++ and used object-oriented programming utilizing Microsoft Visual C++ to implement a multiprocessing computation-based system called AnatomicAligner in computer-aided simulation for streamlined orthognathic surgical planning.

9. My academic career started at the University of Hawaii at Manoa in 1997. Two years later, I moved to Texas A&M University. I teach undergraduate courses in circuit theory, signal and systems, digital signal processing, and probability theory. I also teach graduate courses in digital image processing & computer vision, advanced digital signal processing, random processes, information theory, pattern recognition, data compression, and network information theory and coding.

10. I was a visiting professor at the Houston Methodist Hospital Research Institute during 2011-2013, working on design, development and clinical validation of computer-aided surgical simulation system for streamlined orthognathic surgical planning, application of cone-

beam computed tomography on dentomaxillofacial imaging and orthodontic practice, and digital dental model articulation.

11. Because of my Ph.D. thesis work on the best wavelet-based image codec, I was fortunate to receive three prestigious research awards in my early career: an NSF Career Award in 1999, an ARO Young Investigator Award in 2000, and an ONR Young Investigator Award in 2001. These grants allowed me to fund graduate students and postdocs to work on distributed video coding.

12. In 2004, I was invited to write a feature article entitled "Distributed source coding for sensor networks" for the IEEE Signal Processing Magazine – the most cited IEEE journal according to the annual Journal Citation Report (2003 edition) published by the Institute for Scientific Information. This article subsequently received the 2006 IEEE Signal Processing Magazine best paper award. In the same year, I was elevated to an IEEE fellow for my contribution to source and channel coding. At that time, I was still an associate professor.

13. I am also co-recipient of top 10% paper awards at the 2011 and 2015 IEEE Multimedia Signal Processing (MMSP) Workshops, an IBM best student paper award at the 2016 IEEE International Conference on Pattern Recognition (ICPR), and the best demo paper award at the 2018 IEEE International Conference on Multimedia and Expo (ICME).

14. I was a visiting professor in (a) the Department of Electrical Engineering at Stanford University in Spring 2010, and (b) the Department of Electrical and Computer Systems Engineering, Monash University, Melbourne, Australia during 2016-2018.

15. I served as an associate editor for the IEEE Transactions on Circuits and Systems for Video Technology (1999-2005), the IEEE Transactions on Image Processing (2002-2005), the IEEE Transactions on Signal Processing (2002-2006), the IEEE Transactions on Systems, Man,

and Cybernetics (part B) (2005-2009), the IEEE Transactions on Communications (2008-2013), and the IEEE Transactions on Multimedia (2017-2020). I also served as a guest editor for IEEE Signal Processing Magazine: Special Issue on Signal Processing for Multiterminal Communication Systems, September 2007, and IEEE Journal of Selected Topics in Signal Processing: Special Issue on MIMO-Optimized Transmission Systems for Delivering Data and Rich Content, April 2008.

16. I served as chair of video and image processing track of IEEE ICME in 2003; publications chair of the IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP) in 2007; technical program committee co-chair of the IEEE Information Theory Workshop (ITW) in 2007; Tutorial chair of IEEE International Symposium on Information Theory (ISIT) in 2010; award chair of IEEE Global Communications Conference (Globecom) in 2014; and general co-chair of IEEE MMSP Workshop in 2017.

17. I was an invited Panelist on Distributed Video Coding: Trends and Challenges at the IEEE Picture Coding Symposium (PCS) in 2007. I also co-organized special sections on topics related to distributed source/video coding, distributed joint source-channel coding, and networked video at major conferences such as IEEE ICASSP, IEEE International Conference on Image Processing (ICIP), IEEE ICME, and IEEE/SPIE International Conference on Visual Communications and Image Processing (VCIP). I was also a tutorial presenter on these topics at ICASSP 2005, VCIP 2005, ICME 2007, Globecom 2007, and VCIP 2010.

18. I served on the IEEE Signal Processing Society Multimedia Signal Processing Technical Committee, the IEEE Communications Society Multimedia Communications Technical Committee, and the IEEE Circuits and Systems Society Multimedia Systems & Applications Technical Committee. I also served on the IEEE Transactions Circuits and Systems for Video

Technology best paper award committee and was the best paper award chair for the IEEE Transactions Multimedia in 2017 and 2018. I was elected as a Distinguished Lecturer of the IEEE Circuits and Systems Society for 2008-2009.

19. Additional qualifications are included in my CV, which is attached as Exhibit A. My CV also identifies the cases that I have testified as an expert at trial or by deposition in.

III. LEGAL STANDARD

20. I am not an attorney. For the purposes of this declaration, I have been informed about certain aspects of the law that are relevant to my conclusions expressed herein. My understanding of the law is as follows.

A. CLAIM CONSTRUCTION

21. I understand that patent claim terms are generally given their ordinary and customary meaning. That is the meaning the term would have for a person of ordinary skill in the art at the time of the claimed invention—i.e., when the application for the patent was filed.

22. I understand that claim terms should be understood in the context of the claim as a whole. I further understand that the patent's specification is relevant to the meaning of a claim term. I understand that the claims must be read in light of the specification. I also understand that the file history may be considered when interpreting the meaning of a patent's claims.

23. I understand that the claim language, specification, and file history are called "intrinsic evidence," and are the most important tools for determining the meaning of a claim term. I also understand that other evidence, such as testimony from the inventors named on the patent at issue, dictionaries, treaties, and other evidence of the understanding of persons of ordinary skill in the art can be relevant in determining how a person of ordinary skill in the art would understand the claims. I understand that this evidence, which is called "extrinsic evidence," should be considered in the context of the intrinsic evidence and cannot be used to change the meaning of a

claim term to be inconsistent with the intrinsic evidence. Evidence and opinions from an expert in the field regarding a claim term's meaning is another type of extrinsic evidence.

B. INDEFINITENESS

24. I have been informed and understand the Patent Act (35 U.S.C. § 112 ¶ 2) requires a patent specification to conclude with claims "particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention." I understand that a patent claim that does not meet this standard is invalid as indefinite. I understand that a claim is indefinite if, when read in light of the patent specification and prosecution history, the claim fails to inform a person of ordinary skill in the art, with reasonable certainty, about the scope of the claimed invention. I understand that absolute or mathematical precision is not required in a claim, but a claim must, when read in light of the specification and the prosecution history, provide objective boundaries for those of skill in the art.

C. MEANS-PLUS-FUNCTION

25. I understand that the Patent Act allows "means-plus-function" claims, which are governed by 35 U.S.C. § 112, ¶ 6, printed below:

> An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.

26. I understand that claim limitations that recite the word "means" are presumptively interpreted as means-plus-function claims under 35 U.S.C. § 112, ¶ 6.

27. I understand that the construction of a means-plus-function limitation under 35 U.S.C. § 112, ¶ 6, requires a two-step approach.

28. I understand that the first step is to identify the claimed function, staying true to the claim language and the limitations expressly recited by the claims. One must be careful not to

adopt a function different from that explicitly recited in the claim, because an error in identification of the function could improperly alter the identification of the structure corresponding to that function.

29. I understand that the second step is to ascertain the corresponding structures in the written description that perform those functions. A disclosed structure is corresponding if the specification clearly links or associates that structure to the function recited in the claim. I understand that it is improper to import into the claim structural limitations from the written description that are unnecessary to perform the claimed function.

30. I understand that the specification must contain sufficient descriptive text by which a person of skill in the field of the invention would know and understand what structure corresponds to the means limitation. I further understand that when the disclosed structure for a means-plus-function claim is a computer or microprocessor, the disclosed structure is not the general-purpose computer by itself, and the specification must disclose the algorithm for performing the function. The specification can express the algorithm in any understandable terms including as a mathematical formula, in prose, or as a flow chart, or in any other manner that provides sufficient structure. The algorithm—regardless of its form—must describe how the function is performed. I understand that it is not enough for the specification to provide examples of the results of the operation of an unspecified algorithm.

IV. THE TREATMENT PLANNING PATENTS

A. OVERVIEW

31. I understand that Align has asserted that ClearCorrect infringes all of the claims of the Treatment Planning Patents. That is, Align has asserted that ClearCorrect infringes claims 1-42 of the ’444 patent, claims 1-20 of the ’217 patent, claims 1-24 of the ’879 patent, and claims 1-19 of the ’456 patent.

32. The ’444 patent is titled “Automated Treatment Staging for Teeth.”[1] I understand that the inventors on the ’444 patent are Ian Kitching, Alexander Dmitriev, and Alexey Vishnevskiy. I also understand that the ’444 patent claims priority to two provisional applications that were both filed on August 30, 2006.

33. For the purposes of my analysis, I have assumed that the priority date for the ’444 patent is August 30, 2006.

34. The Abstract of the ’444 patent states that:

> Apparatus, system, and methods for utilizing one or more computing devices to stage the movement of teeth during an alignment treatment are disclosed. The computing device receives an electronic representation of the patient’s teeth in their initial position and an electronic representation of the teeth a final position for each tooth. A route each tooth will travel to reach its final position is determined, and the teeth are scheduled to move according to a movement pattern. Moreover, the schedule of movement takes into account a maximum rate of tooth movement for each tooth, the path of movement for each tooth, the distance each tooth needs to move, any needed tooth staggering, any needed round-tripping or tooth movement slowing. The invention also includes techniques for determining an optimum number of stages for the treatment based on the schedule of movement.

35. The Field of the Invention section of the ’444 patent states:

> The present invention is related generally to the field of orthodontics, and more particularly to staging a path of movement for correcting the position of one or more teeth. ’444 patent, 1:18.

36. The ’444 patent states that “[i]n currently available systems for providing clear, removable tooth aligners, it is often necessary to manually manipulate digital and/or physical models of a patient's teeth to plan movements of the teeth through their various treatment stages,

[1] The other treatment planning patents (i.e., the ’217 patent, the ’879 patent, and the ’456 patent) share the same title, figures, and specification with the ’444 patent. Therefore, the discussion in this section regarding the ’444 patent’s specification and figures is also applicable to the other treatment planning patents.

and, thus, to manufacture the corresponding stages of aligners." '444 patent, 1:45-50. The '444 patent purportedly addresses the "need … for apparatus, systems, and methods to increase automation of a tooth movement treatment planning process." '444 patent, 1:64-66; *see id*. at 1:50-53.

37. The '444 patent states that the "present invention provide[s] apparatus, systems, and methods for automated staging of teeth, from an initial position to a final, corrected position" and that, "[d]epending upon the particular needs of the patient, the patient's teeth are scheduled to move according to various movement patterns, routes, rates, and/or distances; and the need for utilizing tooth staggering, round-tripping, and/or slowing techniques." '444 patent, 2:6-12. "Furthermore, the invention provides techniques for minimizing the treatment period of the patient based upon the pattern, route, rate, and/or distance selected for the patients individual needs, as well as the need for any tooth staggering, round-tripping and/or slowing technique(s)." '444 patent, 2:12-17.

B. DISPUTED CLAIM TERMS

38. I understand that ClearCorrect and Align dispute the proper construction of several different claim terms. With respect to the Treatment Planning Patents, I have been asked to analyze only the parties' disputes regarding the Means-Plus-Function terms (i.e., the claim terms that being with the term "means"). In particular, I have been asked to analyze whether the specification discloses an algorithm for the computer to perform the stated function.

1. "means for receiving an electronic representation of each dental object of the plurality of dental objects in relation to one another" (Claim 15)

Term	ClearCorrect's Proposed Construction	Align's Proposed Construction
"means for receiving an electronic representation of each dental object of the plurality of dental objects in relation to one another" '444 patent, cl. 15	Subject to § 112 ¶ 6 • Function: receiving an electronic representation of each dental object of the plurality of dental objects in relation to one another • Structure: None Indefinite	a computing device and equivalents *E.g.*, '444 patent, 5:12-16

a. The Claimed Function

39. As discussed above, I understand the first step in a means-plus-function analysis is to determine what the claimed function is.

40. I have reviewed the parties' proposed constructions, reproduced above, and Align has not identified a function, while ClearCorrect has stated that the function is "receiving an electronic representation of each dental object of the plurality of dental objects in relation to one another." In light of my review of the '444 patent and the prosecution history, I agree that the function that ClearCorrect identified is the correct function for the claim—it mirrors the claim language.

b. The Alleged Sufficient Structure

41. As discussed above, I understand the second step of a means-plus-function analysis then requires ascertaining whether the specification discloses sufficient corresponding structure.

42. Align identifies the '444 patent 5:12-16 as providing structure for this term.[2] I have reproduced this portion of the specification below.

> In accordance with one exemplary embodiment, a computing device is configured to receive an electronic representation of the patient's teeth in an initial position taken by, for example, an intra-oral scanner (i.e., a CT scanner) based on an impression or partial impression of the patient's teeth.

43. This passage does not provide structure for performing the function of "receiving an electronic representation of each dental object of the plurality of dental objects in relation to one another."

44. This passage refers to only a generic "computing device" that "is configured to receive an electronic representation of the patient's teeth in an initial position taken" and thus largely repeats the claimed function without identifying any structure other than a computing device. The specification does not provide any software algorithm or any other guidance or particular method by which the computing device is to be configured to receive an electronic representation of the patent's teeth. In addition, this passage does not make reference to how the "electronic representation of each dental object of the plurality of dental objects [is] ***in relation to one another***" (emphasized).

45. Accordingly, for at least these reasons, Align has not cited, and I have not found, any sufficient structure for performing the function of "receiving an electronic representation of each dental object of the plurality of dental objects in relation to one another."

[2] While Align's disclosure of proposed constructions does not expressly state what it contends is sufficient structure, I understand that the parties are in agreement that each of the Means-Plus-Function terms are governed by § 112, ¶ 6. In light of this, I have used the specification citations following the "*E.g.*," in Align's October 10, 2024 Disclosure of Proposed Constructions as what Align contends provides sufficient structure in the specification. This point holds true for each of the Means-Plus-Function terms I discuss in my declaration.

2. "means for receiving an electronic representation of a desired final position for each respective dental object" (Claim 15)

Term	ClearCorrect's Proposed Construction	Align's Proposed Construction
"means for receiving an electronic representation of a desired final position for each respective dental object" '444 patent, cl. 15	Subject to § 112 ¶ 6 • Function: receiving an electronic representation of a desired final position for each respective dental object • Structure: None Indefinite	a computing device and equivalents *E.g.*, '444 patent, 5:16-19

a. The Claimed Function

46. I have reviewed the parties' proposed constructions, reproduced above, and Align has not identified a function, while ClearCorrect has stated that the function is "receiving an electronic representation of a desired final position for each respective dental object." In light of my review of the '444 patent and the prosecution history, I agree that the function that ClearCorrect identified is the correct function for the claim—it mirrors the claim language.

b. The Alleged Sufficient Structure

47. Align identifies the '444 patent, 5:16-19 as providing sufficient structure for this term. I have reproduced this portion of the specification below.

> In addition, the computing device is configured to receive or generate an electronic representation of a desired final position for each of the patient's teeth.

48. This passage does not provide structure for performing the function of "receiving an electronic representation of a desired final position for each respective dental object."

49. As with the prior limitation, this passage refers only to a generic "computing device" that is "configured to receive or generate an electronic representation of a desired final position for each of the patient's teeth." The specification does not provide any sort of algorithm or any other guidance or particular method by which the computing device is to be "configured" to receive or generate an electronic representation of a desired final position for each of the patient's teeth.

50. Accordingly, for at least these reasons, Align has not cited, and I have not found, any sufficient structure for performing the function of "receiving an electronic representation of a desired final position for each respective dental object."

3. "means for determining an order of movement for each respective dental object such that the dental objects avoid colliding with each other on their respective routes from said initial position to said desired final position" (Claim 15)

Term	ClearCorrect's Proposed Construction	Align's Proposed Construction
"means for determining an order of movement for each respective dental object such that the dental objects avoid colliding with each other on their respective routes from said initial position to said desired final position" '444 patent, cl. 15	Subject to § 112 ¶ 6 • Function: determining an order of movement for each respective dental object such that the dental objects avoid colliding with each other on their respective routes from said initial position to said desired final position • Structure: None Indefinite	a computer program that performs the steps identified in Figure 2B and equivalents *E.g.*, '444 patent, 5:19-22, 5:29-6:46, Fig. 2B

a. The Claimed Function

51. I have reviewed the parties' proposed constructions, reproduced above, and Align has not identified a function, while ClearCorrect has stated that the function is "determining an order of movement for each respective dental object such that the dental objects avoid colliding with each other on their respective routes from said initial position to said desired final position." In light of my review of the '444 patent and the prosecution history, I agree that the function that ClearCorrect identified is the correct function for the claim—it mirrors the claim language.

b. The Alleged Sufficient Structure

52. Align identifies the '444 patent, 5:19-22, 5:29-6:46, and Fig 2B as providing sufficient structure for this term. I discuss each of these portions of the specification in turn and have reproduced them below.

53. The ***first*** passage Align cites to is '444 patent, 5:19-22, which I have reproduced below.

> The program stored within the computing device is configured to analyze the initial and final positions, and automatically create a route for each tooth to move from its initial position to its final position.

54. This passage does not provide structure for performing the function of "determining an order of movement for each respective dental object such that the dental objects avoid colliding with each other on their respective routes from said initial position to said desired final position."

55. As an initial matter, this passage does not refer to any sort of algorithm. It simply refers to a "program stored within the computing device" and describes what functions that computer program may perform, which includes being "configured to analyze the initial and final positions, and automatically create a route for each tooth to move from its initial position to its final position." Thus, there is no algorithm described in this passage.

56. This passage also does not refer to all of the aspects of the claimed function. For example, this passage does not even mention collision avoidance. It therefore provides no information on this aspect of the function.

57. The ***second*** passage Align cites to is '444 patent, 5:29-6:46, which I have reproduced below.

> FIG. 2B is a flow diagram illustrating a plurality of patterns and options available to a system user and a computing device for optimizing the movement of a patient's teeth during treatment. After the computing device generates the electronic representation of the patient's teeth with respect to the desired final position, in accordance with an exemplary embodiment, the system user can decide which pattern, or combination of patterns thereof, to suitably utilize for moving the patient's teeth to achieve the desired final position, for example, by determining whether the patient's teeth does not require complex movements, and/or has gaps, crowding or are otherwise skewed. The computer program then calculates the planned stages in between the current and desired final position. If the patient does not require complex movements, an "all-equal" pattern 300 (discussed below) of teeth movement can be selected by the system user and utilized by the program. For patients having too much space between teeth (i.e., gaps between teeth), the system user can enable the program to be configured to utilize an "A-shaped" pattern 400 (discussed below) to coordinate the movement of the patient's teeth. For the opposite case (i.e., crowded teeth), the system user can enable the program to be configured to utilize a "V-shaped" pattern 500 (discussed below) to coordinate the movement of the patient's teeth. If a patient's teeth are skewed to the left or right of the patient's mid-line, a "Mid-Line Shift" pattern 600 (discussed below) for small shifts or a Mid-Line Shift pattern 600' (discussed below) can be selected by the system user to enable the program to coordinate the staged movement of the patient's teeth. For a set of teeth having gaps between both posterior and anterior teeth, the system user can enable the program to be configured to utilize an "M-shaped" pattern 700 (discussed below) to coordinate teeth movement. In addition, any other treatment patterns can be suitably selected from other orthodontic treatment patterns for treating space closure, reproximation, dental expansion, flaring, distalization, and/or lower incisor extraction, such as those patterns disclosed in U.S. Pat. No. 6,729,876, entitled "Tooth Path Treatment Plan" issued on May 4, 2004 and assigned to Align Technology, Inc.

Selection of a pattern, e.g., patterns for addressing all equal, gapped, crowded or skewed teeth, can be suitably determined by the system user through use of one or more command or input screens of a computing device. For example, in accordance with an exemplary embodiment, a computing device can be configured to allow the system user to assess the initial and desired final positions of a patient's teeth and then suitably select from such command screens appropriate movement patterns, as well as the extent or degree of stages within any pattern and/or the severity of the teeth misalignment, the speed of movement during treatment for each of the teeth and other treatment criteria. Such a configuration can include various known orthodontic treatment protocols, or any devised hereinafter.

While an exemplary embodiment may be configured to have a system user select a suitably pattern for treatment, in accordance with another exemplary embodiment, the computer program can be suitably configured to determine and select such a pattern. For example, by measuring distances of movement needed and/or otherwise analyzing the electronic representation of the patient's teeth in initial and final positions, and then based on algorithms to determine whether the teeth need approximately all-equal movement, or whether the teeth are gapped, crowded or skewed, or some combination thereof, the computer program can select a suitable pattern for treatment planning.

After the system user and/or computer program has decided which pattern to utilize, the system user can determine, and/or computer program is configured to determine, if the pattern should be modified to accommodate the teeth movement of the current patient to avoid collision. In accordance with an exemplary embodiment, to determine whether a collision is likely, the computer program can suitably calculate distances between a first tooth and a second tooth and then apply geometrical techniques, such as those disclosed in disclosed in U.S. Pat. No. 6,729,876, entitled "Tooth Path Treatment Plan" issued on May 4, 2004 and assigned to Align Technology, Inc.

In one embodiment, the program is configured to "stagger", "round trip" and/or slow the movement (each of which is discussed below, respectively) of one or more teeth if the patient's teeth cannot be moved without colliding with and/or obstructing another tooth/teeth. Based on that assessment, the program determines the most efficient path to take through some combination of patterns and accommodation of movement thereof.

58. This passage also does not provide structure for performing the function of "determining an order of movement for each respective dental object such that the dental objects avoid colliding with each other on their respective routes from said initial position to said desired final position."

59. This passage does not refer to any sort of algorithm for determining an order of movement so that teeth avoid colliding with each other. The first paragraph of passage starts by describing Figure 2B. In this discussion, the specification describes a series of different movement patterns that that are "available to a system user and a computing device." This passage also discusses how "the system user can decide which pattern, or combination of patterns thereof, to suitably utilize for moving the patient's teeth to achieve the desired final position." It then refers to a series of different movement patterns (e.g., A-shaped, V-shaped, etc.). Nowhere does this paragraph provide an algorithm that can be used for collision avoidance.

60. The second and third paragraphs, similar to the first, also do not mention collision avoidance. Instead, these paragraphs refer to how the "[s]election of a pattern … can be suitably determined by the system user through one or more command or input screens of a computing device" or how "an exemplary embodiment may be configured to have a system user select a suitably pattern for treatment" where "the computer program can be suitably configured to determine and select such a pattern." The third paragraph does refer "algorithms" to determine a suitable movement pattern based on the initial positions of the patient's teeth, but the specification does not disclose what those algorithms are, and as noted, this discussion has nothing to do with collision avoidance.

61. The fourth and fifth passages do refer to avoiding collision, but do not describe any algorithm for how collision avoidance is to occur.

62. For example, paragraph the fourth paragraph states that "the system user can determine, and/or computer program is configured to determine, if the pattern should be modified to accommodate the teeth movement of the current patient to avoid collision." This paragraph does not describe how it is determined whether a collision will occur (i.e., there is no algorithm). Nor does this paragraph describe any algorithm for the computer to determine an order of movement "such that the dental objects ***avoid colliding with each other on their respective routes***" (emphasized). There is simply no algorithm or description of how this function occurs.

63. The fifth (and last cited) paragraph states that "the program is configured to 'stagger', 'round trip' and/or slow the movement (each of which is discussed below, respectively) of one or more teeth if the patient's teeth cannot be moved without colliding with and/or obstructing another tooth/teeth." This also does not constitute an algorithm for avoiding collisions. Rather, this language is akin to telling an air traffic controller that he or she can ensure that airplanes do not collide by using some combination of basic techniques—e.g., delaying planes, accelerating planes, or moving planes to another runway. But the description of possible techniques one might use in an algorithm is not the disclosure of an algorithm. This passage simply provides no limitations on how the use of staggering, round-tripping, or slowing the movement of teeth are combined, weighted, or decided to be used to perform collision avoidance. This is underscored by the last sentence of the paragraph which states, "[b]ased on that assessment, the program determines the most efficient path to take through some combination of patterns and accommodation of movement thereof." There is simply no guidance on how the most efficient path is determined; nor how a "combination of patterns and accommodation of movement" is weighed to arrive at the "most efficient path."

64. The ***third*** passage Align cites to is Figure 2B, which I have reproduced below.

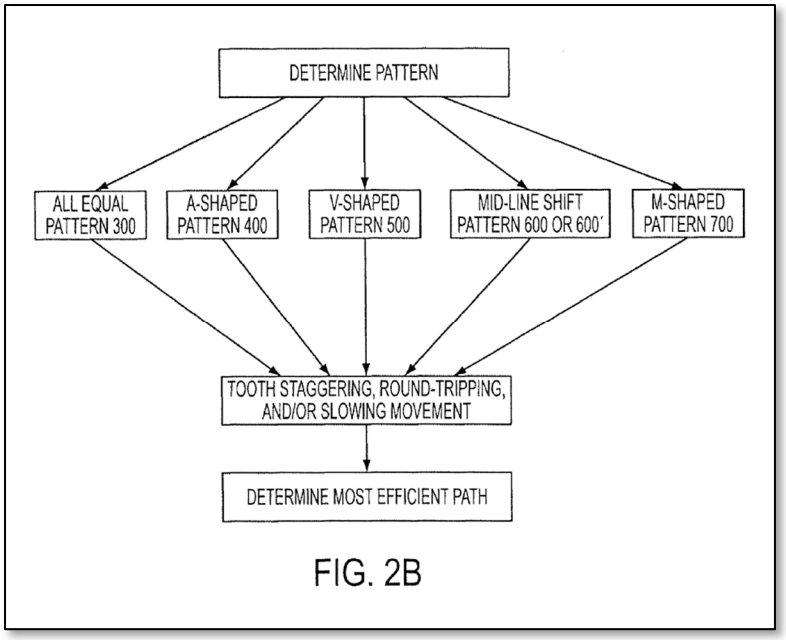

FIG. 2B

65. Figure 2B is a pictorial depiction of the first passage discussed above. Nothing in this picture adds structure beyond the text I discussed in paragraphs 57-63 above. Indeed, this flow diagram does even mention collision avoidance and provides no algorithm for how that claimed function is performed.

66. Moreover, the last box in Figure 2B simply recites "determine most efficient path" but provides no guidance at all on how to determine what constitutes the most efficient path; nor does the specification provide any guidance. Figure 2B provides no information on how one is supposed to combine picking a pattern term with one or more "movement" (like tooth staggering, round-tripping, and/or slowing movement.

67. As discussed above, individually none of the cited portions provide sufficient structure for performing the function of "determining an order of movement for each respective dental object such that the dental objects avoid colliding with each other on their respective routes from said initial position to said desired final position." Nor does reading these portions of the specification together provide sufficient structure for performing the claimed function.

Accordingly, Align has not cited, and I have not found, any sufficient structure for performing the function of "determining an order of movement for each respective dental object such that the dental objects avoid colliding with each other on their respective routes from said initial position to said desired final position."

4. "means for determining a route each respective dental object will move to achieve its respective final position" (Claim 16)

Term	ClearCorrect's Proposed Construction	Align's Proposed Construction
"means for determining a route each respective dental object will move to achieve its respective final position" '444 patent, cl. 16	Subject to § 112 ¶ 6 • Function: determining a route each respective dental object will move to achieve its respective final position • Structure: None Indefinite	a computer program that is configured to segment an initial digital dataset into digital models of individual dental objects and gingival tissue, calculate a transformation for each dental object, and then calculate one or more intermediate positions for each dental object, taking into account any constraints imposed on the movement of dental objects and any collisions that might occur between dental objects as the dental objects move from one treatment stage to the next and equivalents *E.g.*, '444 patent, 3:19-24, 3:36-61

a. The Claimed Function

68. I have reviewed the parties' proposed constructions, reproduced above, and Align has not identified a function, while ClearCorrect has stated that the function is "determining a route each respective dental object will move to achieve its respective final position." In light of my

review of the ’444 patent and the prosecution history, I agree that the function that ClearCorrect identified is the correct function for the claim—it mirrors the claim language.

b. The Alleged Sufficient Structure

69. Align identifies two passages of the ’444 patent as providing sufficient structure for this term: ’444 patent, 3:19-24 and 3:36-61. I discuss each of these portions of the specification in turn and have reproduced them below.

70. The ***first*** passage Align cites to is ’444 patent, 3:19-24, which I have reproduced below.

> For example, one such technique involves receiving an initial data set that represents the patient’s teeth before treatment, specifying a desired arrangement of the patient’s teeth after treatment, and calculating transformations that will move the teeth from the initial to the final positions over desired treatment paths.

71. This passage does not provide structure for performing the function of “determining a route each respective dental object will move to achieve its respective final position.”

72. As an initial matter, this passage does not refer to any sort of algorithm. The passage refers to performing the functions of receiving data, specifying a desired arrangement, and calculating transformations. But the passage does not describe how any of these functions are performed or implemented.

73. The ***second*** passage Align cites to is ’444 patent, 3:36-61, which I have reproduced below.

> FIGS. 1A, **1**B, and **1**C show a patient’s dentition at three stages during a course of treatment. FIG. 1A illustrates the initial positions of the patient’s teeth before treatment begins. A digital model of the teeth at these initial positions is captured in an initial digital data set (IDDS). The digital model contained in the IDDS also includes portions representing gingival tissue surrounding the patient's teeth. A computer program segments the IDDS into digital models of individual teeth and the gingival tissue.

> FIG. 1B illustrates an example of how the patient's teeth may be oriented at an intermediate stage in the treatment process, and FIG. 1C illustrates an example of how the patient's teeth may be oriented at their final positions. A human operator and/or a computer program manipulate the digital models of the patient's teeth to achieve the final tooth positions. The program then calculates one or more of the intermediate positions, taking into account any constraints imposed on the movement of the teeth by the human operator or by the natural characteristics of the teeth themselves. The program also accounts for any collisions that might occur between teeth as the teeth move from one treatment stage to the next. Selecting the final and intermediate tooth positions and the treatment paths along which the teeth move is described in more detail in one or more of the Patent Applications discussed above, which are all hereby incorporated by reference, in their respective entireties.

74. As an initial matter, this passage also does not refer to any sort of algorithm.

75. This passage refers to and describes three figures (Figures 1A, 1B, and 1C). Those figures are stylized cartoon images of a patient's teeth. There is no algorithm or any sort of discussion regarding how a computer program is to perform "determining a route each respective dental object will move to achieve its respective final position."

76. Nor does the rest of the passage provide any algorithm or description of how a computer program is to perform "determining a route each respective dental object will move to achieve its respective final position." For example, stating that a "human operator and/or a computer program manipulate the digital models of the patient's teeth to achieve the final tooth positions," does not describe how the route is determined. Likewise, stating that the "program also accounts for any collisions that might occur between teeth as the teeth move from one treatment stage to the next," does not provide any detail on how the route is determined.

77. The passage concludes with referencing how "[s]electing the final and intermediate tooth positions and the treatment paths along which the teeth move is described in more detail in one or more of the Patent Applications discussed above, which are all hereby incorporated by

reference, in their respective entireties." This language also does not describe how the function of for "determining a route each respective dental object will move to achieve its respective final position." I also understand from counsel that a patent specification cannot rely on the incorporation of other references to provide the necessary structure for a means-plus-function term. But even if such incorporation by reference were permissible, the specification's general reference to a number of other patent applications fails to link any specific structure to the claimed function, which, as noted above, I understand is required for means-plus-function claims.

78. As discussed above, individually none of the cited portions provide sufficient structure for performing the function of "determining a route each respective dental object will move to achieve its respective final position." Nor does reading these portions of the specification together provide structure for performing the claimed function. Accordingly, Align has not cited, and I have not found, any sufficient structure for performing the function of "determining a route each respective dental object will move to achieve its respective final position."

5. "means for determining the distance each respective dental object will move to achieve its respective final position" (Claim 16)

Term	ClearCorrect's Proposed Construction	Align's Proposed Construction
"means for determining the distance each respective dental object will move to achieve its respective final position" '444 patent, cl. 16	Subject to § 112 ¶ 6 • Function: determining the distance each respective dental object will move to achieve its respective final position • Structure: None Indefinite	a computer program that determines the distance each respective dental object will move to achieve its respective final position and equivalents *E.g.*, '444 patent, 4:58-5:10

a. The Claimed Function

79. I have reviewed the parties' proposed constructions, reproduced above, and Align has not identified a function, while ClearCorrect has stated that the function is "determining the distance each respective dental object will move to achieve its respective final position." In light of my review of the '444 patent and the prosecution history, I agree that the function that ClearCorrect identified is the correct function for the claim—it mirrors the claim language.

b. The Alleged Sufficient Structure

80. Align identifies the '444 patent, 4:58-5:10 as providing sufficient structure for this term. I have reproduced this portion of the specification below.

> As those skilled in the art will appreciate, any computing device utilized by a user may include an operating system (e.g., Windows NT, 95/98/2000, OS2, UNIX, Linux, Solaris, MacOS, etc.) as well as various conventional support software and drivers typically associated with computers. As will be appreciated by one of ordinary skill in the art, each computing device may be embodied as a customization of an existing system, an add-on product, upgraded software, a stand alone system, a distributed system, a method, a data processing system, a device for data processing, and/or a computer program product. Accordingly, any program stored therein may take the form of an entirely software embodiment, an entirely hardware embodiment, or an embodiment combining aspects of both software and hardware. Furthermore, any program may take the form of a computer program product on a computer-readable storage medium having computer-readable program code means embodied in the storage medium. Any Suitable computer-readable storage medium may be utilized, including hard disks, CD-ROM, optical storage devices, magnetic storage devices, and/or the like.

81. This passage does not provide structure for performing the function of "determining the distance each respective dental object will move to achieve its respective final position."

82. As an initial matter, this passage does not refer to any sort of algorithm. Instead, this passage refers to "any computing device utilized by a user." But "any computing device" cannot perform the function of "determining the distance each respective dental object will move to achieve its respective final position."

83. The remainder of this passage, which refers to the computing device potentially having an operating system, "conventional support software," or generally referring to "any program" does not provide any guidance on how the function of "determining the distance each respective dental object will move to achieve its respective final position." Nor would any such computing device with these additional features be able to perform the function of "determining the distance each respective dental object will move to achieve its respective final position."

84. For at least these reasons, the specification fails to provide sufficient structure for performing the function of "determining the distance each respective dental object will move to achieve its respective final position." Accordingly, for at least these reasons, Align has not cited, and I have not found, any sufficient structure for performing the function of "determining the distance each respective dental object will move to achieve its respective final position."

6. "means for determining a rate at which each respective dental object will move along its respective route" (Claim 16)

Term	ClearCorrect's Proposed Construction	Align's Proposed Construction
"means for determining a rate at which each respective dental object will move along its respective route" '444 patent, cl. 16	Subject to § 112 ¶ 6 • Function: determining a rate at which each respective dental object will move along its respective route • Structure: None Indefinite	a computer program that determines a rate at which each respective dental object will move along its respective route *E.g.*, '444 patent, 4:58-5:10

a. The Claimed Function

85. I have reviewed the parties' proposed constructions, reproduced above, and Align has not identified a function, while ClearCorrect has stated that the function is "determining a rate at which each respective dental object will move along its respective route." In light of my review

of the ’444 patent and the prosecution history, I agree that the function that ClearCorrect identified is the correct function for the claim—it mirrors the claim language.

b. The Alleged Sufficient Structure

86. Align identifies the ’444 patent, 4:58-5:10 as providing sufficient structure for this term. I have reproduced this portion of the specification below.

> As those skilled in the art will appreciate, any computing device utilized by a user may include an operating system (e.g., Windows NT, 95/98/2000, OS2, UNIX, Linux, Solaris, MacOS, etc.) as well as various conventional support software and drivers typically associated with computers. As will be appreciated by one of ordinary skill in the art, each computing device may be embodied as a customization of an existing system, an add-on product, upgraded software, a stand alone system, a distributed system, a method, a data processing system, a device for data processing, and/or a computer program product. Accordingly, any program stored therein may take the form of an entirely software embodiment, an entirely hardware embodiment, or an embodiment combining aspects of both software and hardware. Furthermore, any program may take the form of a computer program product on a computer-readable storage medium having computer-readable program code means embodied in the storage medium. Any Suitable computer-readable storage medium may be utilized, including hard disks, CD-ROM, optical storage devices, magnetic storage devices, and/or the like.

87. This passage does not provide structure for performing the function of “determining a rate at which each respective dental object will move along its respective route.”

88. As an initial matter, this passage does not refer to any sort of algorithm.

89. Instead, this passage refers to “any computing device utilized by a user.” Any computing device cannot perform the function of “determining a rate at which each respective dental object will move along its respective route.”

90. The remainder of this passage, which refers to the computing device potentially having an operating system, “conventional support software,” or generally referring to “any program” does not provide any guidance on how the function of “determining a rate at which each

respective dental object will move along its respective route." Nor would any such computing device with these additional features be able to perform the function of "determining a rate at which each respective dental object will move along its respective route."

91. I also note that the specification separately discloses, in a passage that Align does not cite, that "[t]he system user and/or program can suitably select a rate of tooth movement for each stage, such as by system user input on a command screen, or by computer algorithm." '444 patent, 7:12-14. But despite mentioning the use of computer algorithms, the specification is absolutely silent as to what that algorithm should be.

92. Accordingly, for at least these reasons, Align has not cited, and I have not found, any sufficient structure for performing the function of "determining a rate at which each respective dental object will move along its respective route."

7. "means for determining (a), (b), and (c) in relation to each of the other dental objects" (Claim 17)

Term	ClearCorrect's Proposed Construction	Align's Proposed Construction

"means for determining (a), (b), and (c) in relation to each of the other dental objects" '444 patent, cl. 17	Subject to § 112 ¶ 6 • Function: determining (a), (b), and (c) in relation to each of the other dental objects • Structure: None Indefinite	a computer program that is configured to segment an initial digital dataset into digital models of individual dental objects and gingival tissue, calculate a transformation for each dental object, and then calculate one or more intermediate positions for each dental object, taking into account any constraints imposed on the movement of dental objects and any collisions that might occur between dental objects as the dental objects move from one treatment stage to the next and equivalents *E.g.*, '444 patent, 3:19-24, 3:36-61

a. The Claimed Function

93. As an initial matter, I note that (a), (b), and (c) are the (a), (b), and (c) terms from claim 16.

94. I have reviewed the parties' proposed constructions, reproduced above, and Align has not identified a function, while ClearCorrect has stated that the function is "determining (a), (b), and (c) in relation to each of the other dental objects." In light of my review of the '444 patent and the prosecution history, I agree that the function that ClearCorrect identified is the correct function for the claim—it mirrors the claim language.

b. The Alleged Sufficient Structure

95. Align identifies two passages of the '444 patent as providing sufficient structure for this term: '444 patent,3:19-24 and 3:36-61. I discuss each of these portions of the specification in turn and have reproduced them below. I also note that these are the same portions Align

identified as providing sufficient structure for "means for determining a route each respective dental object will move to achieve its respective final position."

96. The ***first*** passage Align cites to is '444 patent, 3:19-24, which I have reproduced below.

> For example, one such technique involves receiving an initial data set that represents the patient's teeth before treatment, specifying a desired arrangement of the patient's teeth after treatment, and calculating transformations that will move the teeth from the initial to the final positions over desired treatment paths.

97. This passage does not provide structure for performing the function of "determining a route each respective dental object will move to achieve its respective final position."

98. As an initial matter, this passage does not refer to any sort of algorithm.

99. Instead, this passage refers to performing the functions of receiving data, specifying a desired arrangement, and calculating transforms. The passage does not describe how any of these functions are performed or implemented.

100. The ***second*** passage Align cites to is '444 patent, 3:36-61, which I have reproduced below.

> FIGS. 1A, **1**B, and **1**C show a patient's dentition at three stages during a course of treatment. FIG. 1A illustrates the initial positions of the patient's teeth before treatment begins. A digital model of the teeth at these initial positions is captured in an initial digital data set (IDDS). The digital model contained in the IDDS also includes portions representing gingival tissue surrounding the patient's teeth. A computer program segments the IDDS into digital models of individual teeth and the gingival tissue.
>
> FIG. 1B illustrates an example of how the patient's teeth may be oriented at an intermediate stage in the treatment process, and FIG. 1C illustrates an example of how the patient's teeth may be oriented at their final positions. A human operator and/or a computer program manipulate the digital models of the patient's teeth to achieve the final tooth positions. The program then calculates one or more of the intermediate positions, taking into account any constraints imposed on the movement of the teeth by the human

> operator or by the natural characteristics of the teeth themselves. The program also accounts for any collisions that might occur between teeth as the teeth move from one treatment stage to the next. Selecting the final and intermediate tooth positions and the treatment paths along which the teeth move is described in more detail in one or more of the Patent Applications discussed above, which are all hereby incorporated by reference, in their respective entireties.

101. As an initial matter, this passage also does not refer to any sort of algorithm.

102. This passage refers to and describes three figures (Figures 1A, 1B, and 1C). Those figures are cartoons of a patient's teeth. There is no algorithm or any sort of discussion regarding how a computer program is to perform "determining (a), (b), and (c) in relation to each of the other dental objects."

103. Nor does the rest of the passage provide any algorithm or description of how a computer program is to perform "determining (a), (b), and (c) in relation to each of the other dental objects." For example, stating that a "human operator and/or a computer program manipulate the digital models of the patient's teeth to achieve the final tooth positions," does not describe how (a), (b), and (c) are determined in relation to another. Likewise, stating that the "program also accounts for any collisions that might occur between teeth as the teeth move from one treatment stage to the next," does not provide any detail on how the route is determined.

104. The passage concludes with referencing how "[s]electing the final and intermediate tooth positions and the treatment paths along which the teeth move is described in more detail in one or more of the Patent Applications discussed above, which are all hereby incorporated by reference, in their respective entireties." This language also does not describe how the function of for "determining (a), (b), and (c) in relation to each of the other dental objects." As noted above, I understand from counsel that a patent specification cannot rely on the incorporation of other references to provide the necessary structure for a means-plus-function term, and in any event, the

general reference here to other patent applications does not provide the required linking of any specific structure to the claimed function.

105. As discussed above, individually none of the cited portions provide sufficient structure for performing the function of "determining (a), (b), and (c) in relation to each of the other dental objects." Nor does reading these portions of the specification together provide sufficient structure for performing the claimed function. Accordingly, for at least these reasons, Align has not cited, and I have not found, any sufficient structure for performing the function of "determining (a), (b), and (c) in relation to each of the other dental objects."

8. "means for adjusting at least one of the route and the rate of at least one dental object to avoid collision with at least one other dental object" (Claim 18)

Term	ClearCorrect's Proposed Construction	Align's Proposed Construction
"means for adjusting at least one of the route and the rate of at least one dental object to avoid collision with at least one other dental object" '444 patent, cl. 18	Subject to § 112 ¶ 6 • Function: adjusting at least one of the route and the rate of at least one dental object to avoid collision with at least one other dental object • Structure: None Indefinite	a computer program that performs collision avoidance via round-tripping, staggering, or slowing, wherein the computer program first attempts staggering of the teeth movement, followed by slowing-down/interim key frames if the staggering does not avoid collisions, and then followed by round-tripping as a last resort and equivalents p *E.g.*, '444 patent, 12:41-65

a. The Claimed Function

106. I have reviewed the parties' proposed constructions, reproduced above, and Align has not identified a function, while ClearCorrect has stated that the function is "adjusting at least one of the route and the rate of at least one dental object to avoid collision with at least one other dental object." In light of my review of the '444 patent and the prosecution history, I agree that

the function that ClearCorrect identified is the correct function for the claim—it mirrors the claim language.

b. The Alleged Sufficient Structure

107. Align identifies '444 patent,12:41-65 as providing sufficient structure for this term. I have reproduced this portion of the specification below.

> As referenced above, in cases where teeth may collide with or obstruct one another during movement, the program is configured to suitably stagger, slow down and/or plan-round tripping for the teeth movement. "Staggering" is the process of delaying one or more teeth from moving one or more stages where it would otherwise move in order to prevent another tooth from colliding with and/or obstructing the path of the delayed tooth. "Slowing down" is the process of having one or more teeth scheduled to move at a rate less than the rate of other teeth, or even stopping using interim key frames, so that collisions and/or obstructions do not occur. "Round-tripping" is the technique of moving a first tooth out of the path of a second tooth, and once the second tooth has moved sufficiently, moving the first tooth back to its previous position before proceeding to a desired final position of that first tooth. Such staggering, slowing down and/or round-tripping can be suitably applied alone or in combination, and in any order. In an exemplary embodiment, the computer program first attempts staggering of the teeth movement, followed by slowing-down/interim key frames if the staggering does not avoid collisions, and then followed by round-tripping as a last resort. In addition, each of staggering, slowing down and round-tripping techniques can be applied to any of the patterns discussed above, or any other movement patterns hereinafter developed in the field of orthodontics.

108. This passage does not provide structure for performing the function of "adjusting at least one of the route and the rate of at least one dental object to avoid collision with at least one other dental object."

109. I understand from counsel that the term "at least one of" when used in a conjunctive list (i.e., the listing of two or more options with an "and" as opposed to an "or") means that both options must happen. Put another way, I understand that the language "adjusting at least one of the route and the rate" requires adjusting both the route and the rate.

110. This passage starts by stating that "in cases where teeth may collide with or obstruct one another during movement, the program is configured to suitably stagger, slow down and/or plan-round tripping for the teeth movement." As I discussed above, 63language like this does not constitute an algorithm for avoiding collisions. Rather, this language is akin to telling an air traffic controller that he or she can avoid airplane collisions by "suitably" using basic techniques such as delaying planes, accelerating planes, or moving planes to another runway. But the description of possible techniques one might use in an algorithm and saying one should use them "suitably" is not the disclosure of an algorithm. This passage thus provides no algorithm; indeed, it provides no guidance whatsoever regarding how staggering, round-tripping, or slowing the movement of teeth are chosen, combined, or weighted in order to perform collision avoidance.

111. The next portion of this passage provides definitions for staggering, slowing down, round tripping. These definitions do not provide an algorithm for "adjusting at least one of the route and the rate of at least one dental object to avoid collision with at least one other dental object." Instead, this passage merely describes potential options. Using the air traffic control example, this is simply defining what it would mean to delay or accelerate a plane or move it to another runway.

112. The next portion of this passage provides a priority for which collision avoidance technique should be used—prioritizing staggering, then slowing down, and then round tripping as a last resort. This too does not constitute an algorithm for "adjusting at least one of the route and the rate of at least one dental object to avoid collision with at least one other dental object." For example, there is no discussion of how to determine whether the collision would be avoided. This portion of the passage just states that if a collision is detected, the software should consider staggering, if that does not work, consider slowing down, and if that does not work, consider round

tripping. The specification also does not disclose anything about how to configure the required computer program, much less describe how to perform staggering, slowing down, or round tripping—e.g., how long to stagger the movement of a tooth, how much to slow down the movement of a tooth, how much to change the route of a tooth. There is simply no algorithm to perform the required function.

113. Moreover, if the computer program ultimately selected the options of staggering or slowing down, then only the rate (as opposed to the route) would be adjusted for the particular tooth. That is because, based on the definitions provided in the specification, neither staggering nor slowing down results in a change of the route for a particular tooth. Instead, only the rate of the movement would be changed.

114. The last portion states that these techniques can be used with any patterns. This language does not provide not an algorithm, but just broadly describes additional use cases.

115. Accordingly, for at least these reasons, Align has not cited, and I have not found, any sufficient structure for performing the function of "adjusting at least one of the route and the rate of at least one dental object to avoid collision with at least one other dental object."

9. "means for determining an optimal number of stages for the order of movement of the dental objects" (Claim 19)

Term	ClearCorrect's Proposed Construction	Align's Proposed Construction
"means for determining an optimal number of stages for the order of movement of the dental objects" '444 patent, cl. 19	Subject to § 112 ¶ 6 • Function: determining an optimal number of stages for the order of movement of the dental objects • Structure: None Indefinite	a computer program that determines an optimal number of stages by selecting the largest number of the minimum number of stages needed to place the dental objects in their final, desired positions and equivalents *E.g.*, '444 patent, 15:6-20

a. The Claimed Function

116. I have reviewed the parties' proposed constructions, reproduced above, and Align has not identified a function, while ClearCorrect has stated that the function is "determining an optimal number of stages for the order of movement of the dental objects." In light of my review of the '444 patent and the prosecution history, I agree that the function that ClearCorrect identified is the correct function for the claim—it mirrors the claim language.[3]

b. The Alleged Sufficient Structure

117. Align identifies the '444 patent, 15:6-20 as providing sufficient structure for this term. I have reproduced this portion of the specification below.

> In one exemplary embodiment, determining the optimum number of stages includes determining the minimum number of stages needed for each respective tooth to be placed in its final, desired position. In another exemplary embodiment, the optimum number of stages is the largest number of the minimum stages needed to place the patient's teeth in their final, desired position. For example, a patient has three teeth that need to be moved during treatment, wherein the first tooth needs 4 stages to move to its final position, the second tooth needs 9 stages to move to its final position, and the third tooth needs 6 stages to move to its final position. Assuming each of these teeth is scheduled to begin moving at the same stage, the optimum number of stages is 9 since this is the minimum number of stages needed to place all of the teeth in their final position.

[3] I understand from counsel that Dr. Harrell, an orthodontist, has opined on whether the term "an optimal number of stages for the order of movement of the dental objects" is indefinite. I have reviewed his analysis regarding the "an optimal number of stages for the order of movement of the dental objects." Based on his analysis and coupled with my experience, there is no objective method by which computer scientists or programmers could write software to determine "an optimal number of stages for the order of movement of the dental objects." Each programmer would necessarily have to implement a subjective weighting of orthodontic treatment factors, which would mean that different programs would result in different numbers of stages, even for the same patient.

118. This passage does not provide structure for performing the function of "determining an optimal number of stages for the order of movement of the dental objects."

119. As an initial matter, this passage does not refer to any sort of algorithm.

120. The passage describes that "determining the optimum number of stages includes ***determining the minimum number of stages***" (emphasized). But the passage does not describe how the computer program is to determine the "minimum of stages" for a particular tooth. While the example provides the 'number' of stages for different teeth and then picks the smallest number, it does not describe how the number of stages themselves are determined. Put another way, using the example in the specification, nowhere does the specification describe how to determine that the first tooth needs a minimum number of 4 stages, the second tooth needs a minimum number of 9 stages, and the third tooth needs a minimum number of six stages. Thus, this passage does not describe how to perform "determining an optimal number of stages for the order of movement of the dental objects." This passage simply provides examples of the results of the operation using an unspecified algorithm.

121. Accordingly, for at least these reasons, Align has not cited, and I have not found, any sufficient structure for performing the function of "determining an optimal number of stages for the order of movement of the dental objects."

10. "means for determining a total distance each respective dental object will move" (Claim 20)

Term	ClearCorrect's Proposed Construction	Align's Proposed Construction

"means for determining a total distance each respective dental object will move" '444 patent, cl. 20	Subject to § 112 ¶ 6 • Function: determining a total distance each respective dental object will move • Structure: None Indefinite	a computer program for determining a total distance each respective dental object will move and equivalents *E.g.*, '444 patent, 4:58-5:10

a. The Claimed Function

122. I have reviewed the parties' proposed constructions, reproduced above, and Align has not identified a function, while ClearCorrect has stated that the function is "determining a total distance each respective dental object will move." In light of my review of the '444 patent and the prosecution history, I agree that the function that ClearCorrect identified is the correct function for the claim—it mirrors the claim language.

b. The Alleged Sufficient Structure

123. Align identifies the '444 patent, 4:58-5:10 as providing sufficient structure for this term. I have reproduced this portion of the specification below.

> As those skilled in the art will appreciate, any computing device utilized by a user may include an operating system (e.g., Windows NT, 95/98/2000, OS2, UNIX, Linux, Solaris, MacOS, etc.) as well as various conventional support software and drivers typically associated with computers. As will be appreciated by one of ordinary skill in the art, each computing device may be embodied as a customization of an existing system, an add-on product, upgraded software, a stand alone system, a distributed system, a method, a data processing system, a device for data processing, and/or a computer program product. Accordingly, any program stored therein may take the form of an entirely software embodiment, an entirely hardware embodiment, or an embodiment combining aspects of both software and hardware. Furthermore, any program may take the form of a computer program product on a computer-readable storage medium having computer-readable program code means embodied in the storage medium. Any Suitable computer-readable storage medium may be utilized, including hard disks, CD-

ROM, optical storage devices, magnetic storage devices, and/or the like.

124. This passage does not provide structure for performing the function of "determining a total distance each respective dental object will move."

125. As an initial matter, this passage does not refer to any sort of algorithm.

126. Instead, this passage refers to "any computing device utilized by a user." Any computing device cannot perform the function of "determining a total distance each respective dental object will move."

127. The remainder of this passage, which refers to the computing device potentially having an operating system, "conventional support software," or generally referring to "any program" does not provide any guidance on how the function of "determining a total distance each respective dental object will move." Nor would any such computing device with these additional features be able to perform the function of "determining a total distance each respective dental object will move."

128. For at least these reasons, the specification fails to provide sufficient structure for performing the function of "determining a total distance each respective dental object will move." Accordingly, for at least these reasons, Align has not cited, and I have not found, any sufficient structure for performing the function of "determining a total distance each respective dental object will move."

11. "means for dividing the total distance for each dental object by its respective maximum speed to determine a number of movement stages for each dental object" (Claim 20)

Term	ClearCorrect's Proposed Construction	Align's Proposed Construction

"means for dividing the total distance for each dental object by its respective maximum speed to determine a number of movement stages for each dental object;" '444 patent, cl. 20	Subject to § 112 ¶ 6 • Function: dividing the total distance for each dental object by its respective maximum speed to determine a number of movement stages for each dental object • Structure: None Indefinite	computer program for dividing the total distance for each dental object by its respective maximum speed to determine a number of movement stages for each dental object and equivalents e *E.g.*, '444 patent, 4:58-5:10

a. The Claimed Function

129. I have reviewed the parties' proposed constructions, reproduced above, and Align has not identified a function, while ClearCorrect has stated that the function is "dividing the total distance for each dental object by its respective maximum speed to determine a number of movement stages for each dental object." In light of my review of the '444 patent and the prosecution history, I agree that the function that ClearCorrect identified is the correct function for the claim—it mirrors the claim language.

b. The Alleged Sufficient Structure

130. Align identifies '444 patent, 4:58-5:10 as providing sufficient structure for this term. I have reproduced this portion of the specification below.

> As those skilled in the art will appreciate, any computing device utilized by a user may include an operating system (e.g., Windows NT, 95/98/2000, OS2, UNIX, Linux, Solaris, MacOS, etc.) as well as various conventional support software and drivers typically associated with computers. As will be appreciated by one of ordinary skill in the art, each computing device may be embodied as a customization of an existing system, an add-on product, upgraded software, a stand alone system, a distributed system, a method, a data processing system, a device for data processing, and/or a computer program product. Accordingly, any program stored therein may take the form of an entirely software embodiment, an entirely hardware embodiment, or an embodiment combining aspects of both software and hardware. Furthermore, any program

> may take the form of a computer program product on a computer-readable storage medium having computer-readable program code means embodied in the storage medium. Any Suitable computer-readable storage medium may be utilized, including hard disks, CD-ROM, optical storage devices, magnetic storage devices, and/or the like.

131. This passage does not provide structure for performing the function of "dividing the total distance for each dental object by its respective maximum speed to determine a number of movement stages for each dental object."

132. As an initial matter, this passage does not refer to any sort of algorithm.

133. Instead, this passage refers to "any computing device utilized by a user." Any computing device cannot perform the function of "dividing the total distance for each dental object by its respective maximum speed to determine a number of movement stages for each dental object."

134. The remainder of this passage, which refers to the computing device potentially having an operating system, "conventional support software," or generally referring to "any program" does not provide any guidance on how the function of "dividing the total distance for each dental object by its respective maximum speed to determine a number of movement stages for each dental object." Nor would any such computing device with these additional features be able to perform the function of "dividing the total distance for each dental object by its respective maximum speed to determine a number of movement stages for each dental object."

135. Accordingly, for at least these reasons, Align has not cited, and I have not found, any sufficient structure for performing the function of "dividing the total distance for each dental object by its respective maximum speed to determine a number of movement stages for each dental object."

12. "means for determining a number of non-movement stages for each respective dental object" (Claim 20)

Term	ClearCorrect's Proposed Construction	Align's Proposed Construction
"means for determining a number of non-movement stages for each respective dental object;" '444 patent, cl. 20	Subject to § 112 ¶ 6 • Function: determining a number of non-movement stages for each respective dental object • Structure: None Indefinite	a computer program for determining a number of non-movement stages for each respective dental object and equivalents *E.g.*, '444 patent, 4:58-5:10

a. The Claimed Function

136. I have reviewed the parties' proposed constructions, reproduced above, and Align has not identified a function, while ClearCorrect has stated that the function is "determining a number of non-movement stages for each respective dental object." In light of my review of the '444 patent and the prosecution history, I agree that the function that ClearCorrect identified is the correct function for the claim—it mirrors the claim language.

b. The Alleged Sufficient Structure

137. Align identifies '444 patent, 4:58-5:10 as providing sufficient structure for this term. I have reproduced this portion of the specification below.

> As those skilled in the art will appreciate, any computing device utilized by a user may include an operating system (e.g., Windows NT, 95/98/2000, OS2, UNIX, Linux, Solaris, MacOS, etc.) as well as various conventional support software and drivers typically associated with computers. As will be appreciated by one of ordinary skill in the art, each computing device may be embodied as a customization of an existing system, an add-on product, upgraded software, a stand alone system, a distributed system, a method, a data processing system, a device for data processing, and/or a computer program product. Accordingly, any program stored therein may take the form of an entirely software embodiment, an entirely hardware embodiment, or an embodiment combining aspects of both software and hardware. Furthermore, any program may take the form of a computer program product on a computer-readable storage medium having computer-readable program code

> means embodied in the storage medium. Any Suitable computer-readable storage medium may be utilized, including hard disks, CD-ROM, optical storage devices, magnetic storage devices, and/or the like.

138. This passage does not provide structure for performing the function of "determining a number of non-movement stages for each respective dental object."

139. As an initial matter, this passage does not refer to any sort of algorithm.

140. Instead, this passage refers to "any computing device utilized by a user." Any computing device cannot perform the function of "determining a number of non-movement stages for each respective dental object."

141. The remainder of this passage, which refers to the computing device potentially having an operating system, "conventional support software," or generally referring to "any program" does not provide any guidance on how the function of "determining a number of non-movement stages for each respective dental object." Nor would any such computing device with these additional features be able to perform the function of "determining a number of non-movement stages for each respective dental object."

142. Accordingly, for at least these reasons, Align has not cited, and I have not found, any sufficient structure for performing the function of "determining a number of non-movement stages for each respective dental object."

13. "means for adding the number of movement stages to the number of non-movement stages for each dental object to determine a minimum number of stages for each respective dental object" (Claim 20)

Term	ClearCorrect's Proposed Construction	Align's Proposed Construction

"means for adding the number of movement stages to the number of non-movement stages for each dental object to determine a minimum number of stages for each respective dental object" '444 patent, cl. 20	Subject to § 112 ¶ 6 • Function: adding the number of movement stages to the number of non-movement stages for each dental object to determine a minimum number of stages for each respective dental object • Structure: None Indefinite	computer program for adding the number of movement stages to the number of non-movement stages for each dental object to determine a minimum number of stages for each respective dental object and equivalents *E.g.*, '444 patent, 4:58-5:10

a. The Claimed Function

143. I have reviewed the parties' proposed constructions, reproduced above, and Align has not identified a function, while ClearCorrect has stated that the function is "adding the number of movement stages to the number of non-movement stages for each dental object to determine a minimum number of stages for each respective dental object." In light of my review of the '444 patent and the prosecution history, I agree that the function that ClearCorrect identified is the correct function for the claim—it mirrors the claim language.

b. The Alleged Sufficient Structure

144. Align identifies the '444 patent, 4:58-5:10 as providing sufficient structure for this term. I have reproduced this portion of the specification below.

> As those skilled in the art will appreciate, any computing device utilized by a user may include an operating system (e.g., Windows NT, 95/98/2000, OS2, UNIX, Linux, Solaris, MacOS, etc.) as well as various conventional support software and drivers typically associated with computers. As will be appreciated by one of ordinary skill in the art, each computing device may be embodied as a customization of an existing system, an add-on product, upgraded software, a stand alone system, a distributed system, a method, a data processing system, a device for data processing, and/or a computer program product. Accordingly, any program stored therein may take the form of an entirely software embodiment, an entirely hardware embodiment, or an embodiment combining

> aspects of both software and hardware. Furthermore, any program may take the form of a computer program product on a computer-readable storage medium having computer-readable program code means embodied in the storage medium. Any Suitable computer-readable storage medium may be utilized, including hard disks, CD-ROM, optical storage devices, magnetic storage devices, and/or the like.

145. This passage does not provide structure for performing the function of "adding the number of movement stages to the number of non-movement stages for each dental object to determine a minimum number of stages for each respective dental object."

146. As an initial matter, this passage does not refer to any sort of algorithm.

147. Instead, this passage refers to "any computing device utilized by a user." Any computing device cannot perform the function of "adding the number of movement stages to the number of non-movement stages for each dental object to determine a minimum number of stages for each respective dental object."

148. The remainder of this passage, which refers to the computing device potentially having an operating system, "conventional support software," or generally referring to "any program" does not provide any guidance on how the function of "adding the number of movement stages to the number of non-movement stages for each dental object to determine a minimum number of stages for each respective dental object." Nor would any such computing device with these additional features be able to perform the function of "adding the number of movement stages to the number of non-movement stages for each dental object to determine a minimum number of stages for each respective dental object."

149. Accordingly, for at least these reasons, Align has not cited, and I have not found, any sufficient structure for performing the function of "adding the number of movement stages to the number of non-movement stages for each dental object to determine a minimum number of stages for each respective dental object."

14. "means for selecting the largest of the minimum number of stages" (Claim 20)

Term	ClearCorrect's Proposed Construction	Align's Proposed Construction
"means for selecting the largest of the minimum number of stages" '444 patent, cl. 20	Subject to § 112 ¶ 6 • Function: selecting the largest of the minimum number of stages • Structure: None Indefinite	a computer program for selecting the largest of the minimum number of stages and equivalents *E.g.*, '444 patent, 4:58-5:10

a. The Claimed Function

150. I have reviewed the parties' proposed constructions, reproduced above, and Align has not identified a function, while ClearCorrect has stated that the function is "selecting the largest of the minimum number of stages." In light of my review of the '444 patent and the prosecution history, I agree that the function that ClearCorrect identified is the correct function for the claim—it mirrors the claim language.

b. The Alleged Sufficient Structure

151. Align identifies '444 patent, 4:58-5:10 as providing sufficient structure for this term. I have reproduced this portion of the specification below.

> As those skilled in the art will appreciate, any computing device utilized by a user may include an operating system (e.g., Windows NT, 95/98/2000, OS2, UNIX, Linux, Solaris, MacOS, etc.) as well as various conventional support software and drivers typically associated with computers. As will be appreciated by one of ordinary skill in the art, each computing device may be embodied as a customization of an existing system, an add-on product, upgraded software, a stand alone system, a distributed system, a method, a data processing system, a device for data processing, and/or a computer program product. Accordingly, any program stored therein may take the form of an entirely software embodiment, an entirely hardware embodiment, or an embodiment combining aspects of both software and hardware. Furthermore, any program

> may take the form of a computer program product on a computer-readable storage medium having computer-readable program code means embodied in the storage medium. Any Suitable computer-readable storage medium may be utilized, including hard disks, CD-ROM, optical storage devices, magnetic storage devices, and/or the like.

152. This passage does not provide structure for performing the function of "selecting the largest of the minimum number of stages."

153. As an initial matter, this passage does not refer to any sort of algorithm.

154. Instead, this passage refers to "any computing device utilized by a user." Any computing device cannot perform the function of "selecting the largest of the minimum number of stages."

155. The remainder of this passage, which refers to the computing device potentially having an operating system, "conventional support software," or generally referring to "any program" does not provide any guidance on how the function of "selecting the largest of the minimum number of stages." Nor would any such computing device with these additional features be able to perform the function of "selecting the largest of the minimum number of stages."

156. Accordingly, for at least these reasons, Align has not cited, and I have not found, any sufficient structure for performing the function of "selecting the largest of the minimum number of stages."

15. "means for ordering the movement of the dental objects in an all-equal pattern" (Claim 21)

Term	ClearCorrect's Proposed Construction	Align's Proposed Construction
"means for ordering the movement of the dental objects in an all-equal pattern" '444 patent, cl. 21	Subject to § 112 ¶ 6 • Function: ordering the movement of the dental objects in an all-equal pattern • Structure: None Indefinite	a computer program configured to utilize the pattern depicted in Figure 3 and equivalents *E.g.*, '444 patent, 6:47-51, 7:27-29, Fig. 3

a. The Claimed Function

157. I have reviewed the parties' proposed constructions, reproduced above, and Align has not identified a function, while ClearCorrect has stated that the function is "ordering the movement of the dental objects in an all-equal pattern." In light of my review of the '444 patent and the prosecution history, I agree that the function that ClearCorrect identified is the correct function for the claim—it mirrors the claim language.

b. The Alleged Sufficient Structure

158. Align identifies the '444 patent, 6:47-51, 7:27-29, Fig. 3 as providing sufficient structure for this term. I discuss each of these portions of the specification in turn and have reproduced them below.

159. The ***first*** passage Align cites to is '444 patent, 6:47-51, which I have reproduced below.

> As discussed above, for patients that do not require complex tooth movement coordination between multiple teeth or for teeth needing relatively simple correction, the program is configured to utilize an "all-equal" pattern in staging a set of aligners to correct the teeth.

160. This passage does not provide structure for performing the function of "ordering the movement of the dental objects in an all-equal pattern."

161. As an initial matter, this passage does not refer to any sort of algorithm. It simply states (1) a use case for the all-equal pattern (i.e., if the patient does not require complex tooth movement); and (2) that a "program is configured" to utilize the pattern. This is not an algorithm and does not describe how the program is configured—just that it is.

162. The ***second*** passage Align cites to is '444 patent,7:27-29, which I have reproduced below.

> FIG. 3 is a diagram representing one example of an "all equal" pattern 300 for moving the teeth of a patient in accordance with one exemplary embodiment of the invention

163. This language is not an algorithm. It provides no information about how the computer program is programmed to perform the function of "ordering the movement of the dental objects in an all-equal pattern."

164. The ***third*** portion Align cites to is Figure 3 of the '444 patent, which I have reproduced below.

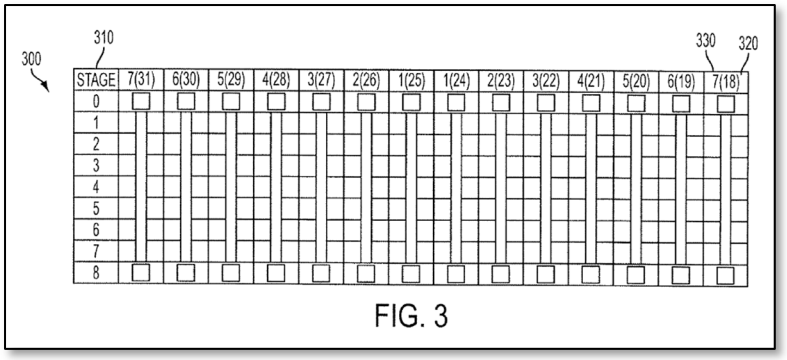

FIG. 3

165. This figure provides no information about an algorithm. It does not provide any information about how the computer program is programmed to perform the function of "ordering the movement of the dental objects in an all-equal pattern."

166. As discussed above, individually none of the cited portions provide any structure for performing the function of "ordering the movement of the dental objects in an all-equal

pattern." Nor does reading these portions of the specification together provide structure for performing the claimed function. Accordingly, Align has not cited, and I have not found, any sufficient structure for performing the function of "ordering the movement of the dental objects to form an all-equal pattern."

167. In addition, notwithstanding my nearly 40 years of experience in the software coding and programming field spanning numerous industries, I have never come across the term "all-equal pattern" used in the Treatment Planning patents

16. "means for ordering the movement of the dental objects in a V-shaped pattern" (Claim 22)

Term	ClearCorrect's Proposed Construction	Align's Proposed Construction
"means for ordering the movement of the dental objects in a V-shaped pattern" '444 patent, cl. 22	Subject to § 112 ¶ 6 • Function: ordering the movement of the dental objects in a V-shaped pattern • Structure: None Indefinite	a computer program configured to utilize the pattern depicted in Figure 5 and equivalents *E.g.*, '444 patent, 9:12-15, 9:42-44, Fig. 5

a. The Claimed Function

168. I have reviewed the parties' proposed constructions, reproduced above, and Align has not identified a function, while ClearCorrect has stated that the function is "ordering the movement of the dental objects in a V-shaped pattern." In light of my review of the '444 patent and the prosecution history, I agree that the function that ClearCorrect identified is the correct function for the claim—it mirrors the claim language.

b. The Alleged Sufficient Structure

169. Align identifies the '444 patent, 9:12-15, 9:42-44 and Fig. 5 as providing sufficient structure for this term. I discuss each of these portions of the specification in turn and have reproduced them below.

170. The ***first*** passage Align cites to is '444 patent, 9:12-15, which I have reproduced below.

> For a set of teeth lacking space in between at least two teeth (i.e., over-crowding), the program is configured to utilize a "V-shaped" pattern in staging a set of aligners to correct the teeth.

171. This passage does not provide structure for performing the function of "ordering the movement of the dental objects in a V-shaped pattern."

172. As an initial matter, this passage does not refer to any sort of algorithm. It simply states (1) a use case for the V-shaped pattern (i.e., a set of teeth lacking space in between at least two teeth; and (2) that a "program is configured" to utilize the pattern. This is not an algorithm and does not describe how the program is configured—just that it is.

173. The ***second*** passage Align cites to is '444 patent, 9:42-44, which I have reproduced below.

> FIG. 5 is a diagram illustrating an example of a "V-shaped" pattern 500 in accordance with one exemplary embodiment of the invention.

174. This language is not an algorithm. It provides no information about how the computer program is programmed to perform the function of "ordering the movement of the dental objects in a V-shaped pattern."

175. The ***third*** portion Align cites to is Fig. 5 of the '444 patent, which I have reproduced below.

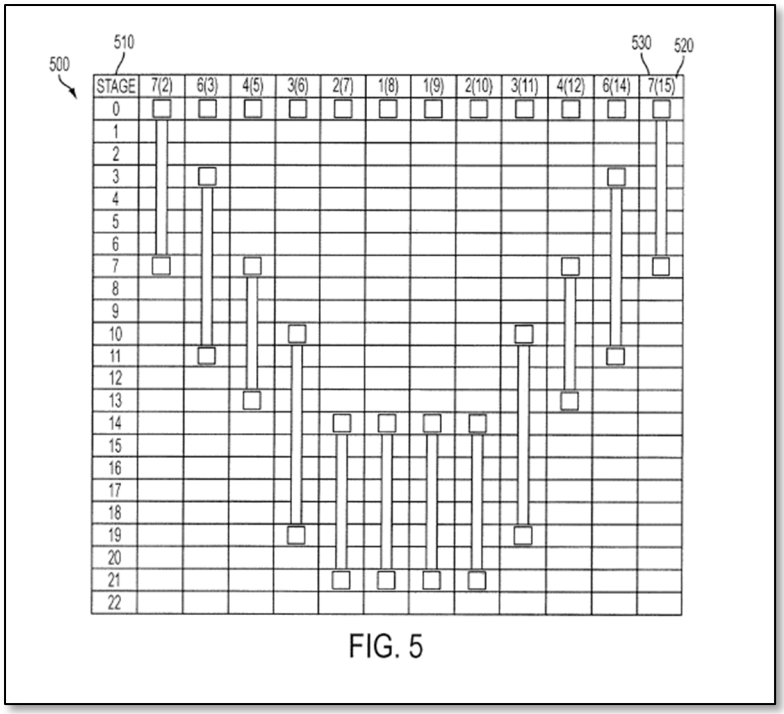

FIG. 5

176. This figure provides no information about an algorithm. It does not provide any information about how the computer program is programmed to perform the function of "ordering the movement of the dental objects in a V-shaped pattern." Nor does it even describe what the particular V-shaped pattern should look like, such as how deep the "V" should be.

177. As discussed above, individually none of the cited portions provide sufficient structure for performing the function of "ordering the movement of the dental objects in a V-shaped pattern." Nor does reading these portions of the specification together provide sufficient structure for performing the claimed function. Accordingly, Align has not cited, and I have not found, any sufficient structure for performing the function of "ordering the movement of the dental objects to form a V-shaped pattern."

178. In addition, notwithstanding my nearly 40 years of experience in the software coding and programming field spanning numerous industries, I have never come across the term "V-shaped pattern" used in the Treatment Planning patents.

17. "means for ordering the movement of the dental objects in an A-shaped pattern" (Claim 23)

Term	ClearCorrect's Proposed Construction	Align's Proposed Construction
"means for ordering the movement of the dental objects in an A-shaped pattern" '444 patent, cl. 23	Subject to § 112 ¶ 6 • Function: ordering the movement of the dental objects in an A-shaped pattern • Structure: None Indefinite	a computer program configured to utilize the pattern depicted in Figure 4 and equivalents *E.g.*, '444 patent, 7:47-49, 8:26-28, Fig. 4

a. The Claimed Function

179. I have reviewed the parties' proposed constructions, reproduced above, and Align has not identified a function, while ClearCorrect has stated that the function is "ordering the movement of the dental objects in an A-shaped pattern." In light of my review of the '444 patent and the prosecution history, I agree that the function that ClearCorrect identified is the correct function for the claim—it mirrors the claim language.

b. The Alleged Sufficient Structure

180. Align identifies the '444 patent, 7:47-49, 8:26-28, Fig. 4 as providing sufficient structure for this term. I discuss each of these portions of the specification in turn and have reproduced them below.

181. The ***first*** passage Align cites to is the '444 patent, 7:47-49, which I have reproduced below.

> For a set of teeth having gaps between at least two posterior teeth, the program is configured to utilize an "A-shaped" pattern in staging a set of aligners to correct the teeth.

182. This passage does not provide structure for performing the function of "ordering the movement of the dental objects in an A-shaped pattern."

183. As an initial matter, this passage does not refer to any sort of algorithm. It simply states (1) a use case for the A-shaped pattern (i.e., a set of teeth having gaps between at least two posterior teeth); and (2) that a "program is configured" to utilize the pattern. This is not an algorithm and does not describe how the program is configured—just that it is.

184. The ***second*** passage Align cites to is '444 patent, 8:26-28, which I have reproduced below.

> FIG. 4 is a diagram illustrating an example of an "A-shaped" pattern 400 in accordance with one exemplary embodiment of the invention.

185. This language is not an algorithm. It provides no information about how the computer program is programmed to perform the function of "ordering the movement of the dental objects in a A-shaped pattern."

186. The ***third*** portion Align cites to is Figure 4 of the '444 patent, which I have reproduced below.

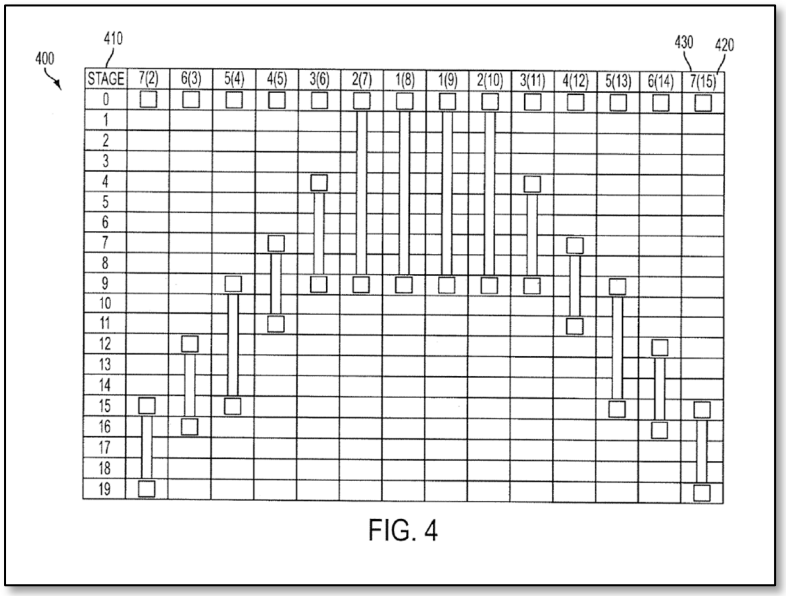

FIG. 4

187. This figure provides no information about an algorithm. It does not provide any information about how the computer program is programmed to perform the function of "ordering the movement of the dental objects in an A-shaped pattern." Nor does it even describe what the particular A-shaped pattern should look like, such as how sharp the "A" should be.

188. As discussed above, individually none of the cited portions provide sufficient structure for performing the function of "ordering the movement of the dental objects in an A-shaped pattern." Nor does reading these portions of the specification together provide any sufficient structure for performing the claimed function. Accordingly, for at least these reasons, Align has not cited, and I have not found, any sufficient structure for performing the function of "ordering the movement of the dental objects in an A-shaped pattern."

189. In addition, notwithstanding my nearly 40 years of experience in the software coding and programming field spanning numerous industries, I have never come across the term "A-shaped pattern" used in the Treatment Planning patents

18. "means for ordering the movement of the dental objects to form an M-shaped pattern" (Claim 24)

Term	ClearCorrect's Proposed Construction	Align's Proposed Construction
"means for ordering the movement of the dental objects to form an M-shaped pattern" '444 patent, cl. 24	Subject to § 112 ¶ 6 • Function: ordering the movement of the dental objects to form an M-shaped pattern • Structure: None Indefinite	a computer program configured to utilize the pattern depicted in Figure 7 and equivalents *E.g.*, '444 patent, 11:41-44, 12:7-9, Fig. 7

a. The Claimed Function

190. I have reviewed the parties' proposed constructions, reproduced above, and Align has not identified a function, while ClearCorrect has stated that the function is "ordering the movement of the dental objects to form an M-shaped pattern." In light of my review of the '444 patent and the prosecution history, I agree that the function that ClearCorrect identified is the correct function for the claim—it mirrors the claim language.

b. The Alleged Sufficient Structure

191. Align identifies the '444 patent, 11:41-44, 12:7-9, Fig. 7 as providing sufficient structure for this term. I discuss each of these portions of the specification in turn and have reproduced them below.

192. The ***first*** passage Align cites to is the'444 patent,11:41-44, which I have reproduced below.

> For a set of teeth having gaps between posterior teeth and anterior teeth, the program is configured to utilize an "M-shaped" pattern in creating a set of aligners to correct the teeth.

193. This passage does not provide structure for performing the function of "ordering the movement of the dental objects to form an M-shaped pattern."

194. As an initial matter, this passage does not refer to any sort of algorithm. It simply states (1) a use case for the M-shaped pattern (i.e., a set of teeth having gaps between posterior teeth and anterior teeth); and (2) that a "program is configured" to utilize the pattern. This is not an algorithm and does not describe how the program is configured—just that it is.

195. The ***second*** passage Align cites to is the '444 patent, 12:7-9, which I have reproduced below.

> FIG. 7 is a diagram illustrating an example of an "M-shaped pattern" 700 in accordance with one exemplary embodiment of the invention.

196. This language is not an algorithm. It provides no information about how the computer program is programmed to perform the function of "ordering the movement of the dental objects to form an M-shaped pattern."

197. The ***third*** portion Align cites to is Figure 7 of the '444 patent, which I have reproduced below.

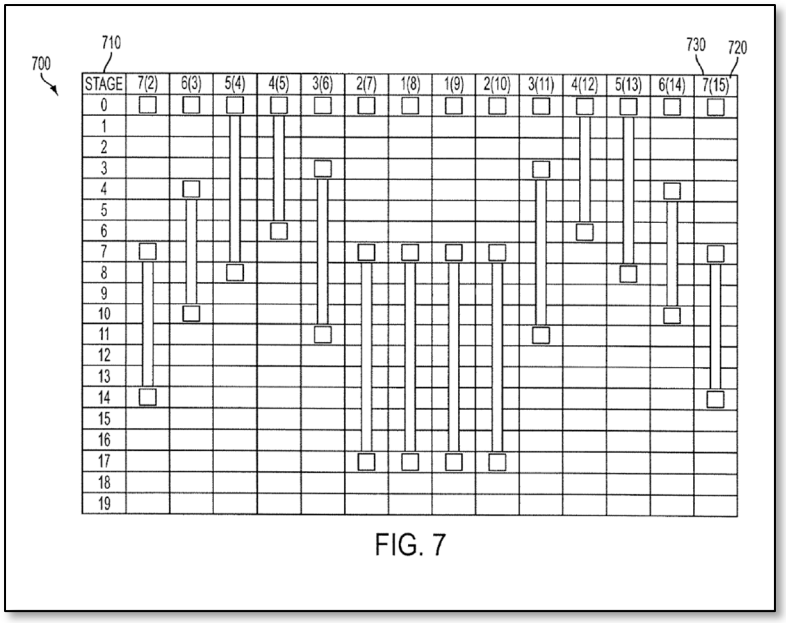

FIG. 7

198. This figure provides no information about an algorithm. It does not provide any information about how the computer program is programmed to perform the function of "ordering the movement of the dental objects to form an M-shaped pattern." Nor does it even describe what the particular M-shaped pattern should look like, such as how sharp or deep the arches in the "M" should be.

199. As discussed above, individually none of the cited portions provide sufficient structure for performing the function of "ordering the movement of the dental objects to form an M-shaped pattern." Nor does reading these portions of the specification together provide sufficient structure for performing the claimed function. Accordingly, Align has not cited, and I have not

found, any sufficient structure for performing the function of "ordering the movement of the dental objects to form an M-shaped pattern."

200. In addition, notwithstanding my nearly 40 years of experience in the software coding and programming field spanning numerous industries, I have never come across the term "M-shaped pattern" used in the Treatment Planning patents.

19. "means for ordering the movement of the dental objects in a mid-line shift pattern" (Claim 25)

Term	ClearCorrect's Proposed Construction	Align's Proposed Construction
"means for ordering the movement of the dental objects in a mid-line shift pattern" '444 patent, cl. 25	Subject to § 112 ¶ 6 • Function: ordering the movement of the dental objects in a mid-line shift pattern • Structure: None Indefinite	a computer program configured to utilize either the pattern depicted in Figure 6A or Figure 6B and equivalents *E.g.*, '444 patent, 10:19-21, 10:57-60, 11:17-20, Fig. 6A, Fig. 6B

a. The Claimed Function

201. I have reviewed the parties' proposed constructions, reproduced above, and Align has not identified a function, while ClearCorrect has stated that the function is "ordering the movement of the dental objects in a mid-line shift pattern." In light of my review of the '444 patent and the prosecution history, I agree that the function that ClearCorrect identified is the correct function for the claim—it mirrors the claim language.

b. The Alleged Sufficient Structure

202. Align identifies the '444 patent, 10:19-21, 10:57-60, 11:17-20, Fig. 6A, Fig. 6B as providing sufficient structure for this term. I discuss each of these portions of the specification in turn and have reproduced them below.

203. The ***first*** passage Align cites to is the '444 patent, 10:19-21, which I have reproduced below.

> For a set of teeth that is off-centered (i.e., skewed to one side), the program is configured to utilize a "mid-line shift" pattern in staging a set of aligners to correct the teeth.

204. This passage does not provide structure for performing the function of "ordering the movement of the dental objects in a mid-line shift pattern."

205. As an initial matter, this passage does not refer to any sort of algorithm. It simply states (1) a use case for the mid-line shift pattern (i.e., a set of teeth that is off-centered); and (2) that a "program is configured" to utilize the pattern. This is not an algorithm and does not describe how the program is configured—just that it is.

206. The ***second*** and ***third*** passages Align cites to are the '444 patent,10:57-60, 11:17-20, which I have reproduced below.

> FIG. 6A is a diagram illustrating an example of a "mid-line shift" pattern 600 for teeth skewed (to the patient's left) less than about 1.0 mm in accordance with one exemplary embodiment of the invention.
>
> FIG. 6B is a diagram illustrating an example of an "mid line shift" pattern 600' for teeth skewed (to the patient's right) more than about 1.0 mm in accordance with one exemplary embodiment of the invention.

207. This language is not an algorithm. Neither passage provides information about how the computer program is programmed to perform the function of "ordering the movement of the dental objects in a mid-line shift pattern."

208. The ***third*** and ***fourth*** portion Align cites to are Figure 6A and Figure 6B of the '444 patent, which I have reproduced below.

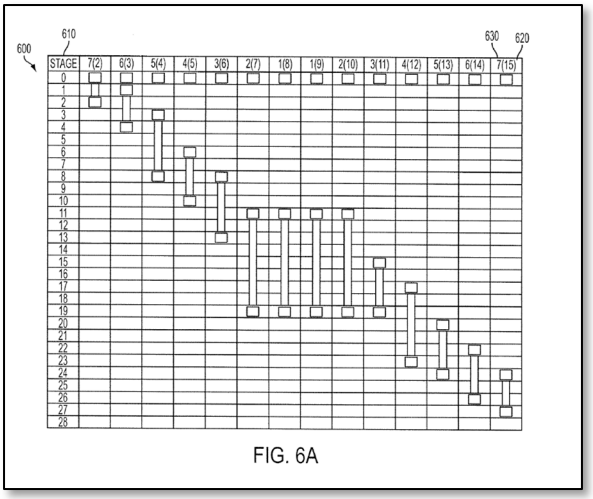

FIG. 6A

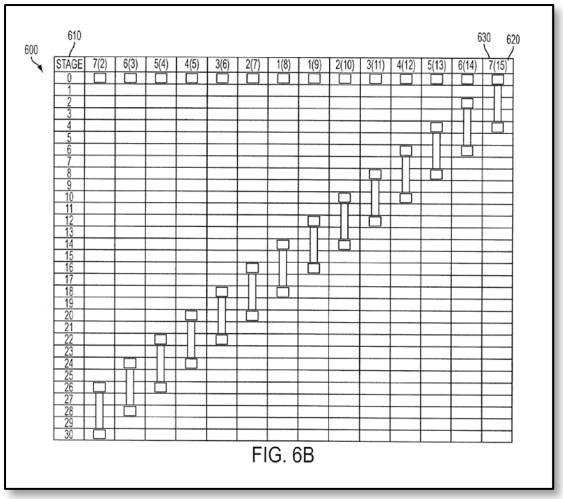

FIG. 6B

209. These figures provide no information about an algorithm. They do not provide any information about how the computer program is programmed to perform the function of "ordering the movement of the dental objects in a mid-line shift pattern."

210. As discussed above, individually none of the cited portions provide sufficient structure for performing the function of "ordering the movement of the dental objects in a mid-line shift pattern." Nor does reading these portions of the specification together provide sufficient structure for performing the claimed function. Accordingly, Align has not cited, and I have not found, any sufficient structure for performing the function of "ordering the movement of the dental objects in a mid-line shift pattern."

211. In addition, notwithstanding my nearly 40 years of experience in the software coding and programming field spanning numerous industries, I have never come across the term "mid-line shift pattern" used in the Treatment Planning patents.

20. "means for staggering the movement of at least two dental objects" (Claim 26)

Term	ClearCorrect's Proposed Construction	Align's Proposed Construction
"means for staggering the movement of at least two dental objects" '444 patent, cl. 26	Subject to § 112 ¶ 6 • Function: staggering the movement of at least two dental objects • Structure: None Indefinite	a computer program configured to delay one or more teeth from moving one or more stages where it would otherwise move in order to prevent another tooth from colliding with and/or obstructing the path of the delayed tooth and equivalents *E.g.*, '444 patent, 12:44-48

a. The Claimed Function

212. I have reviewed the parties' proposed constructions, reproduced above, and Align has not identified a function, while ClearCorrect has stated that the function is "staggering the movement of at least two dental objects." In light of my review of the '444 patent and the prosecution history, I agree that the function that ClearCorrect identified is the correct function for the claim—it mirrors the claim language.

b. The Alleged Sufficient Structure

213. Align identifies the '444 patent, 12:44-48 as providing sufficient structure for this term. I have reproduced this portion of the specification below.

> "Staggering" is the process of delaying one or more teeth from moving one or more stages where it would otherwise move in order to prevent another tooth from colliding with and/or obstructing the path of the delayed tooth.

214. This passage does not provide structure for performing the function of "staggering the movement of at least two dental objects."

215. This passage only provides a definition for "staggering"; it does not provide an algorithm or otherwise explain ***how*** the computer is to be configured to perform the function of "staggering the movement of at least two dental objects."

216. Accordingly, for at least these reasons, Align has not cited, and I have not found, any sufficient structure for performing the function of "staggering the movement of at least two dental objects."

21. "means for round tripping at least one dental object" (Claim 27)

Term	ClearCorrect's Proposed Construction	Align's Proposed Construction
"means for round tripping at least one dental object" '444 patent, cl. 27	Subject to § 112 ¶ 6 • Function: round tripping at least one dental object • Structure: None Indefinite	a computer program configured to move a first tooth out of the path of a second tooth, and once the second tooth has moved sufficiently, move the first tooth back to its previous position before proceeding to a desired final position of the first tooth and equivalents *E.g.*, '444 patent, 12:51-55

a. The Claimed Function

217. I have reviewed the parties' proposed constructions, reproduced above, and Align has not identified a function, while ClearCorrect has stated that the function is "round tripping at least one dental object." In light of my review of the '444 patent and the prosecution history, I agree that the function that ClearCorrect identified is the correct function for the claim—it mirrors the claim language.

b. The Alleged Sufficient Structure

218. Align identifies the '444 patent, 12:51-55 as providing sufficient structure for this term. I have reproduced this portion of the specification below.

> "Round-tripping" is the technique of moving a first tooth out of the path of a second tooth, and once the second tooth has moved sufficiently, moving the first tooth back to its previous position before proceeding to a desired final position of that first tooth.

219. This passage does not provide structure for performing the function of "round tripping at least one dental object."

220. This passage only provides a definition for "round tripping"; it does not provide an algorithm or otherwise explain ***how*** the computer is to be configured to perform the function of "round tripping at least one dental object."

221. Accordingly, for at least these reasons, Align has not cited, and I have not found, any sufficient structure for performing the function of "round tripping at least one dental object."

22. "means for slowing the movement of at least one dental object" (Claim 28)

Term	ClearCorrect's Proposed Construction	Align's Proposed Construction
"means for slowing the movement of at least one dental object" '444 patent, cl. 28	Subject to § 112 ¶ 6 • Function: slowing the movement of at least one dental object • Structure: None Indefinite	a computer program configured to schedule one or more teeth to move at a rate less than the rate of other teeth, or even stopping the one or more teeth using interim key frames, so that collisions and/or obstructions do not occur and equivalents *E.g.*, '444 patent, 12:48-51

a. The Claimed Function

222. I have reviewed the parties' proposed constructions, reproduced above, and Align has not identified a function, while ClearCorrect has stated that the function is "slowing the movement of at least one dental object." In light of my review of the '444 patent and the prosecution history, I agree that the function that ClearCorrect identified is the correct function for the claim—it mirrors the claim language.

b. The Alleged Sufficient Structure

223. Align identifies the '444 patent,12:48-51 as providing sufficient structure for this term. I have reproduced this portion of the specification below.

> "Slowing down" is the process of having one or more teeth scheduled to move at a rate less than the rate of other teeth, or even stopping using interim key frames, so that collisions and/or obstructions do not occur.

224. This passage does not provide structure for performing the function of "slowing the movement of at least one dental object."

225. This passage only provides a definition for "slowing down"; it does not provide an algorithm or otherwise explain ***how*** the computer is to be configured to perform the function of "slowing the movement of at least one dental object."

226. Accordingly, for at least these reasons, Align has not cited, and I have not found, any sufficient structure for performing the function of "slowing the movement of at least one dental object."

V. MATERIALS CONSIDERED

227. In forming my conclusions, I have considered the materials listed below, in addition to any materials referenced in this Declaration.

Description	Bates Number
U.S. Patent No. 8,038,444	
U.S. Patent No. 10,456,217	
U.S. Patent No. 10,524,879	
U.S. Patent No. 11,369,456	
File History for U.S. Patent No. 10,456,217	ALGN00001020- ALGN00001410
File History for U.S. Patent No. 10,524,879	ALGN00001411- ALGN00001822
File History for U.S. Patent No. 11,369,456	ALGN00007541- ALGN00010913
File History for U.S. Patent No. 8,038,444	ALGN00011450 - ALGN00014839
File History for U.S. Patent No. 11,717,381	CC_ALGN_00020187- CC_ALGN_00020436
File History for U.S. Patent No. 10,402,631	CC_ALGN_00020437- CC_ALGN_00020713
File History for U.S. Application No. 18/481,798	CC_ALGN_00020714 - CC_ALGN_00020783
File History for U.S. Patent No. 9,326,830	CC_ALGN_00020784- CC_ALGN_00021291
File History for U.S. Patent No. 11,950,777	CC_ALGN_00021292- CC_ALGN_00021488
U.S. Provisional Application No. 60/824,022	CC_ALGN_00020068- CC_ALGN_00020122
U.S. Provisional Application No. 60/824,024	CC_ALGN_00020123 - CC_ALGN_00020186
Declaration of Dr. William Harrell Jr., DMD	

Dated: October 31, 2024

Zixiang Xiong Ph.D.

EXHIBIT A

ZIXIANG (ZX) XIONG

Department of Electrical and Computer Engineering
Texas A&M University, College Station, TX 77843
Tel: (832) 606-7962
Email: zx@ece.tamu.edu; zxiong@yahoo.com
URL: http://lena.tamu.edu

EXPERTISE

1. Machine learning (ML), artificial intelligence (AI), computer vision, and pattern recognition
   - MLP, RNN, CNN, VGG-16, AlexNet, ResNet, Transformer and MetaFormer.
   - Federated learning
   - Image/video segmentation
   - Face/object recognition & tracking
   - Image denoising/enhancement/super-resolution
   - Image/video inpainting
   - Action detection and recognition
2. Audio/speech/image/video coding
   - MP3, AAC, AMR-NB/WB, FLAC
   - JPEG/JPEG-2000/HEIC/BPG
   - MPEG2/H.263/H.264/H.265/H.266, VP8, VP9, AV1
3. Internet streaming
   - CDN, MPEG2-TS, MPEG4 DASH, WebM, and HLS
4. Audio/image/video processing
   - AR/VR
   - Camera ISP and tuning
   - Mobile remote deposit capture
   - Image data hiding and digital watermarking/fingerprinting
   - Automatic content recognition (ACR)
   - Video summarization
5. 4G LTE and 5G Wireless communications
   - Source and channel coding, turbo equalization, and MIMO OFDM
6. Channel coding
   - Advanced channel coding (turbo/LDPC/polar codes) and erasure codes in storage systems
7. Medical imaging
   - 3D medical/dental imaging and compressive sensing

PROFESSIONAL EMPLOYMENT

2007-present	Professor, Dept of ECE, Texas A&M University
2016-2018	Visiting professor, Dept of ECSE, Monash University, Australia
Spring 2010	Visiting professor, Dept of EE, Stanford University
2002-2007	Associate professor, Dept of ECE, Texas A&M University
1999-2002	Assistant professor, Dept of ECE, Texas A&M University
1997-1999	Assistant professor, Dept of EE, University of Hawaii at Manoa
1995-1997	Visiting student/Research associate, Dept of EE, Princeton University

ADMINISTRATIVE EXPERIENCE

2019-present	Associate department head
2014-2016	Chair of T&P committee, Dept of ECE, Texas A&M U.
2012-2015	Leader, Information Science and Systems group, Dept of ECE, Texas A&M U.

INDUSTRY EXPERIENCE

2013-present	Consultant, Shell Technology Center, Houston, TX
2011-2013	Visiting professor, The Methodist Hospital Res. Inst., Houston, TX
Summer 2000, 2001, 2007 & 2010	Visiting researcher, Microsoft Research, Beijing, China
Winter 1999, 2000, 2003 & 2006	Visiting researcher, Microsoft Research, Beijing, China
Summer 1998 & 1999	Visiting researcher, Microsoft Research, Redmond, WA
1995-1997	MTS (part-time), Sarnoff Corporation, Princeton, NJ

LITIGATION & CONSULTING EXPERIENCE (2020-2024)

27. Law Firm: Troutman Pepper Hamilton Sanders LLP (on behalf of plaintiff VideoLabs, Inc.)
Case No.: Civil Action No. 6:22-cv-00720; Western District of Texas, Waco Division.
Parties: VideoLabs, Inc. v. ASUSTeK Computer Inc.
Claim: Plaintiff alleged patent infringement.
Technology: H.264 & H.265 video compression.
Dates: Oct. 2024-present.
Status: My involvement in this case is ongoing.

26. Law Firm: Troutman Pepper Hamilton Sanders LLP (on behalf of plaintiff VideoLabs, Inc.)
Case No.: Civil Action No. 6:22-cv-01086; Western District of Texas, Waco Division.
Parties: VideoLabs, Inc. v. HP Inc.
Claim: Plaintiff alleged patent infringement.
Technology: H.264 & H.265 video compression.
Dates: Oct. 2024-present.
Status: My involvement in this case is ongoing.

25. Law Firm: WilmerHale LLP (on behalf of defendant ClearCorrect Operating, LLC et al.)
Case No.: Civil action No. 6:24-cv-00187. Western District of Texas, Waco Division.
Parties: Align Technology, Inc. v. ClearCorrect Operating, LLC et al.
Claim: Plaintiff alleged patent infringement.
Technology: 3D medical/dental imaging and treatment planning software.
Dates: Sept. 2024-present.
Status: My involvement in this case is ongoing.

24. Law Firm: Saikrishna Associates, India (on behalf of defendant Transsion Holdings.)
Case No.: CS(COMM) 96/2024 at the High Court of Delhi
Parties: Philips v. Transsion Holdings Co. Ltd.
Claim: Plaintiff alleged patent infringement.
Technology: Audio coding.
Dates: Aug 2024-present.
Status: My involvement in this case is ongoing.

23. Law Firm: Barnes & Thornburg LLP (on behalf of plaintiff Video Solutions Pte. Ltd.)
Case No.: IPR2024-00922.
Parties: Video Solutions Pte. Ltd. v. Cisco Systems, Inc.
Claim: Plaintiff alleged patent infringement.
Technology: Video streaming.

Dates: Aug 2024-present.
Status: My involvement in this case is ongoing.

22. Law Firm: Barnes & Thornburg LLP (on behalf of plaintiff Video Solutions Pte. Ltd.)
Case No.: Civil Action No. 2:23-cv-222-JRG. Eastern District of Texas, Marshall Division.
Parties: Video Solutions Pte. Ltd. v. Cisco Systems, Inc.
Claim: Plaintiff alleged patent infringement.
Technology: Video coding, transmission, and gaming.
Dates: May 2024-present.
Status: My involvement in this case is ongoing.

21. Law Firm: Barnes & Thornburg LLP (on behalf of plaintiff Video Solutions Pte. Ltd.)
Case No.: IPR2024-00194 & IPR 2024-00695.
Parties: Video Solutions Pte. Ltd. v. Cisco Systems, Inc.
Claim: Plaintiff alleged patent infringement.
Technology: Video coding, transmission, and gaming.
Dates: May 2024-present.
Status: I submitted my declaration in June 2024.

20: Law Firm: Farella Braun + Martel LLP (on behalf of defendant Adobe, Inc.)
Case No.: Civil action No. 2:23-cv-06224. Central District of California.
Parties: Jaffe v. Adobe Inc.
Claim: Plaintiff alleged patent infringement.
Technology: Digital fingerprinting and watermarking.
Dates: Mar. 2024-present.
Status: I submitted my declaration in Aug. 2024.

19. Law Firm: Alston & Bird LLP (on behalf of plaintiff Ericsson, Inc.)
Case No.: ITC Investigation No. 337-TA-1387.
Parties: Ericsson, Inc. v. Lenovo Group Limited.
Claim: Plaintiff alleged patent infringement.
Technology: HEVC/H.265 video compression.
Dates: Feb. 2024-present.
Status: I conducted extensive review of source code from Intel (in DC), Qualcomm (in LA), Nvidia (in Palo Alto), Apple (in Palo Alto), Microsoft (in Seattle), and AMD (in Austin) in June 2024. These source codes are mostly written in Verilog or C/C++. I also performed testing of Lenovo's redesigned products (in DC) in July. I submitted my open report on infringement in July 2024 and I was deposed in Aug. 2024.

18. Law Firm: McDonnell Boehnen Hulbert & Berghoff LLP (on behalf of plaintiff the Nielsen Company, LLC)
Case No.: Civil action No. 23-cv-00136-GBW (Consolidated). District of Delaware.
Parties: The Nielsen Company (US), LLC v. Hyphametrics, Inc.
Claim: Plaintiff alleged patent infringement.
Technology: Machine learning based video overlay/logo detection.
Dates: Nov. 2023-present.
Status: I filed my open claim construction report.

17. Law Firm: Spencer Fane LLP (on behalf of plaintiff Quantum Imaging, LLC)
Case No.: Civil action No. 6:22-CV-00573. Western District of Texas, Austin Division.
Parties: Quantum Imaging, LLC v. Sony Entertainment Inc., et al.
Claim: Plaintiff alleged patent infringement.
Technology: Software/Computer Hardware Architecture.

Dates: Oct. 2023-present.

Status: I conducted extensive source code review. I also submitted my declaration in support of plaintiff's opposition to defendant's motion for summary judgement of invalidity. I submitted my report on infringement in July 2024 and I was deposed in Aug. 2024.

16. Law Firm: Alston & Bird LLP (on behalf of plaintiff InterDigital, Inc.)

Case No.: ITC Investigation No. 337-TA-1373.

Parties: InterDigital, Inc. v. Lenovo Group Limited.

Claim: Plaintiff alleged patent infringement.

Technology: VP9/AV1 video compression.

Dates: Apr. 2023-Aug. 2024.

Status: I conducted extensive review of source code from Google, Apple (Palo Alto), Nvidia (in Palo Alto), MediaTek (Birmingham, AL), AMD (in San Francisco), Intel (in San Diego), and Qualcomm (in LA) during Feb-May 2024. These source codes are mostly written in Verilog or C/C++. I also performed testing of Lenovo products in April & May of 2024. I submitted my open and rebuttal report on validity in May 2024 and I was deposed in Jun. 2024. I testified on validity in the Aug. 2024 ITC hearing.

15. Law Firm: Fabricant LLP and McKool Smith (on behalf of plaintiff Advanced Coding Technologies LLC)

Case No.: Civil action No. 2:22-cv-00499-JRG. Eastern District of Texas, Marshall Division.

Parties: Advanced Coding Technologies LLC v. Samsung Electronics Co., Ltd. and LG Electronics Inc.

Claim: Plaintiff alleged patent infringement.

Technology: Multiview video coding and video editing.

Dates: Apr. 2024-Aug. 2024.

Status: I reviewed Samsung's source code in C++ and Verilog (in DC) in May 2024. I also tested Samsung Galaxy Ultra S22 phone in May 2024. I submitted my open report on infringement and rebuttal report on validity in June 2024 and was deposed in July 2024. **The case was settled in Aug. 2024.**

14. Law Firm: Troutman Pepper Hamilton Sanders LLP (on behalf of plaintiff 3Shape A/S)

Case No.: Civil Action No. 6:22-cv-00443-ADA-DTG; Western District of Texas, Waco Division.

Parties: 3Shape A/S v. Medit Corp.

Claim: Plaintiff alleged patent infringement.

Technology: 3D medical/dental imaging.

Dates: Oct. 2022-Oct.2023.

Status: I filed my open claim construction report. My involvement in this case is over. No deposition or trial testimony.

13. Law Firm: Troutman Pepper Hamilton Sanders LLP (on behalf of plaintiff 3Shape A/S)

Case No.: Civil Action No. 1-22-cv-01829-WMR; Northern District of Georgia.

Parties: 3Shape A/S v. Carestream Dental, LLC.

Claim: Plaintiff alleged patent infringement.

Technology: 3D medical/dental imaging.

Dates: October 2022-Oct 2023.

Status: I submitted by declaration in support of 3Shape's opening brief on claim construction in Jan. 2023 and my declaration in support of 3Shape's responsive brief on claim construction in Feb. 2023. No deposition or trial testimony.

12. Law Firm: Troutman Pepper Hamilton Sanders LLP (on behalf of plaintiff VideoLabs, Inc.)

Case No.: ITC Investigation No. 337-TA-1341.

Parties: VideoLabs, Inc. v. HP Inc.

Claim: Plaintiff alleged patent infringement.

Technology: H.264 & H.265 video compression.

Dates: Jan 2023-Oct 2023.

Status: I conducted extensive review of source code from Intel (in DC), Google/AmLogic (in San Francisco), Nvidia (in Palo Alto), and Qualcomm (in LA) during Jan-Feb. 2023. These source codes are mostly written in Verilog (with a small portion in C++). I submitted my expert report on infringement & rebuttal report on validity in Aug. 2023 and I was deposed in Sept. 2023. I testified on infringement and validity in the Oct. 2023 ITC hearing.

11. Law Firm: Finnegan, Henderson, Farabow, Garrett & Dunner, LLP (on behalf of defendant Truist Bank.)

Case No.: Civil Action No. 2:22-cv-00291; Eastern District of Texas, Marshall Division.

Parties: United Services Automobile Association v. Truist Bank.

Claim: Plaintiff alleged patent infringement.

Technology: Mobile remote deposit capture.

Dates: October 2022-October 2023.

Status: My involvement in this case is over. No deposition or trial testimony.

10. Law Firm: Troutman Pepper Hamilton Sanders LLP (on behalf of defendant Capital One Bank USA, N.A.)

Case No.: Civil action No. 1:22-cv-00031-MAC; Eastern District of Texas, Beaumont Division.

Parties: Welch et al v. Capital One Bank USA, N.A. et al.

Claim: Plaintiffs alleged that they never enrolled in the CreditWise service.

Technology: Consumer credit service enrollment and login.

Dates: May 2023 – Oct 2023.

Status: I conducted source code review and submitted my expert report. No deposition or trial testimony.

9. Law Firm: Skiermont Derby LLP

Party: Lens Correction Technologies Corp (LCT).

Technology: Camera image signal processing (ISP) and tuning.

Dates: Feb. 2023-May 2023.

Status: My involvement is over. No deposition or trial testimony.

8. Law Firm: Troutman Pepper Hamilton Sanders LLP (on behalf of plaintiff VideoLabs, Inc.)

Case No.: ITC Investigation No. 337-TA-1323.

Parties: VideoLabs, Inc. v. Acer America Corporation; Acer Inc.; ASUS Computer International; ASUSTeK Computer Inc.; Lenovo Group Limited; Lenovo (United States) Inc.; Micro-Star International Co. Ltd.; Motorola Mobility LLC; MSI Computer Corporation.

Claim: Plaintiff alleged patent infringement.

Technology: H.264 & H.265 video compression.

Dates: August 2022-April 2023.

Status: I conducted extensive review of source code from Intel (in DC), AMD (in Austin), Google/AmLogic (in San Francisco), Nvidia (in Palo Alto), and Qualcomm (in LA) during Jan-Feb. 2023. These source codes are mostly written in Verilog (with a small portion in C++). I submitted my expert report in Feb. 2023 and I was deposed in Mar. 2023. My involvement in this case is over.

7. Law Firm: King & Wood Mallesons (on behalf of plaintiff ZTE Corp.)

Case No.: (2021)粤 03 民初 6820 号; Shenzhen Intermediate People's Court, China.

Parties: ZTE Corp. v. Tinno Mobile.

Claim: Plaintiff alleged patent infringement.

Technology: Wireless communications (4G/LTE & 5G).

Dates: April 2022-December 2022.

Status: The case is settled. No deposition or trial testimony.

6. Law Firm: Baker-Botts LLP

Party: Dell Inc.
Technology: H.265 video compression.
Dates: October 2022-December 2022.
Status: My involvement is over. No deposition or trial testimony.

5. **Law Firm:** McDermott Will & Emery
Party: Dell Inc.
Technology: H.264 & H.265 video compression.
Dates: August 2022-December 2022.
Status: My involvement is over. No deposition or trial testimony.

4. **Law Firm:** Baker-Botts LLP
Party: Dell Inc.
Technology: H.264 & H.265 video compression.
Dates: January 2021-June 2022.
Status: My involvement is over. No deposition or trial testimony.

3. **Law Firm:** Irell & Manella LLP (on behalf of plaintiff StreamScale, Inc.)
Case No.: IPR2021-01330; IPR2021-01408.
Parties: Intel Corporation v. StreamScale, Inc.
Claim: Plaintiff alleged patent infringement.
Technology: Erasure codes & network codes in storage systems.
Dates: February 2022-April 2022.
Status: The case was settled in March 2022. No deposition or trial testimony.

2. **Law Firm:** Questel Orbit Inc.
Party: ZTE Corporation.
Technology: Wireless communications (4G/LTE & 5G).
Dates: October 2020-March 2022.
Status: My involvement is over. No deposition or trial testimony.

1. **Law Firm:** Wilson Sonsini Goodrich & Rosati PC (on behalf of Defendant Bytedance Inc)
Case No.: Class Action No. 5:19-cv-07792; Northern District of California.
Parties: Misty Hong v. Bytedance Inc.; TikTok, Inc., et al.
Claim: Plaintiff alleged personal data collection without permission.
Technology: Mobile image/video sharing and network communications.
Dates: April 2020-Nov. 2020.
Status: I reviewed TikTok's source code remotely in summer'20 for a period of two months and set up a proxy server at home to monitor traffic (e.g., TikTok's) over my iPhone and Galaxy phones. Android version of TikTok's code is written in Java and the iOS version in Swift and Objective-C. I submitted my report in July 2020. **The case was settled in March 2021.**

PROFESSIONAL EXPERIENCE

1. Member: *IEEE Signal Processing Society Multimedia Signal Processing Technical Committee*, 2003-2006.
2. Member: *IEEE Communications Society Multimedia Communications Technical Committee*, 2001-present.
3. Member: *IEEE Circuits and Systems Society Multimedia Systems & Applications Technical Committee*, 2001present.
4. Associate editor: *IEEE Trans. Multimedia*, 2017-2020.
5. Associate editor: *IEEE Trans. Communications*, 2008-2013.
6. Associate editor: *IEEE Trans. Systems, Man, and Cybernetics, Part B*, 2005-2009.
7. Associate editor: *IEEE Trans. Signal Processing*, 2002-2006.

8. Associate editor: *IEEE Trans. Image Processing*, 2002-2005.
9. Associate editor: *IEEE Trans. Circuits and Systems for Video Tech*, 1999-2005.
10. Guest editor: *IEEE Journal on Selected Topics in Signal Processing*, 2008.
11. Guest editor: *IEEE SPM: Special issue on signal processing for multiterminal communication systems*, 2007.
12. Guest editor: *EURASIP Signal Processing: Special issue on distributed source coding*, 2006.
13. Guest editor: *EURASIP JASP: Special issue on multimedia over IP and wireless networks*, February 2004.
14. Tutorial presenter: "Multiterminal video coding: Theory and practice," VCIP'10, Huangshan, July 2010.
15. Tutorial presenter: "Code design for MT comm. networks," Globecom'07, Washington, DC, Nov, 2007.
16. Tutorial presenter: "Distributed video coding: A summary and roadmap," ICME'07, Beijing, July, 2007.
17. Tutorial presenter: "Distributed video coding," VCIP'05, Beijing, China, July 12, 2005.
18. Tutorial presenter: "Distributed source coding: Theory, algorithms and applications," ICASSP'05, 2005.
19. Member of organizing committee, ISBI'25, Houston, TX, 2025.
20. General co-chair, MMSP'17, Luton, UK, 2017.
21. General co-chair, SIDAS'16, Wuhan, China, 2016.
22. Awards chair, Globecom'14, Austin, TX, 2014.
23. Tutorial chair, ISIT'10, Austin, TX, 2010.
24. Technical program committee co-chair, ITW'07, Lake Tahoe, CA, 2007.
25. Publications chair, ICASSP'07, Honolulu, HI, 2007.
26. Publications chair, GENSIPS'06, College Station, TX, 2006.
27. Chair of "Video and image processing" track, ICME'03, Baltimore, MD, July 2003.
28. Invited panelist on "Compressive sensing," Huangshan, Anhui, China, July 13, 2010.
29. Invited panelist on "Distributed video coding: Trends and challenges," PCS'07, Lisbon, Portugal, Nov. 2007.
30. Co-organizer of special session on "Distributed video coding," VCIP'08, San Jose, CA, January 2008.
31. Co-organizer of the Sensor Networks Session at CTW'07, Sedona, AZ, 2007.
32. Co-organizer of the Multiuser Wireless Networks Session at CTW'05, Park City, UT, June 2005.
33. Co-organizer of SS on "Distributed Source and JSCC," ICASSP'05, Philadelphia, PA, March 2005
34. Co-organizer of special session on "Distributed Source Coding," ICIP'03, Barcelona, Spain, September 2003.
35. Co-organizer of special session on "Networked Video," ICME'03, Baltimore, MD, July 2003.
36. Technical program committee member: ICASSP'02-ICASSP'13.
37. Technical program committee member: ICIP'98-ICIP'13.
38. Technical program committee member: ICME'01-ICME'13.
39. Technical program committee member: ISCAS'98-ISCAS'13.
40. Technical program committee member: VCIP'99-VCIP'13.
41. IEEE Trans. Multimedia best paper award committee chair: 2018, 2019.
42. IEEE Trans. Circuits and Systems for Video Tech. best paper award committee member: 2000, 2001, 2005.
43. NSF grant panelist: 2000, 2002, 2008, 2009, 2012, 2013, 2014, 2015, 2021, 2022.

EDUCATION

1996 Ph.D. Electrical Engineering, University of Illinois at Urbana-Champaign
1992 M.S. Electrical Engineering, Illinois Institute of Technology
1991 M.A. Mathematics, University of Kansas

1987 B.S. Electrical Engineering, Wuhan University, P. R. China

CUMMULALTIVE RESEARCH SUPPORT

1. $5.151 million joint grants ($1.68 million prorated) from the National Science Foundation, Qatar National Research Fund, Texas A&M University, and the industry.
2. Additional $1.911 million sole-PI grants from the National Science Foundation, the Office of Naval Research, the Army Research Office, and the industry.

AWARDS AND HONORS

2024	Members-At-Large of Board of Governors Asia-Pacific Signal and Information Processing Association (APSIPA)
2023	Fellow of Asia-Pacific Artificial Intelligence Association (AAIA)
2018	Best demo paper award, 2018 IEEE Intl Conference on Multimedia and Expo
2016	IBM best student paper award, 2016 IEEE Intl Conference on Pattern Recognition
2015	Top 10% paper award, 2015 IEEE Multimedia Signal Processing Workshop
2011&2012	Office of Technology Commercialization's Patent Award, Texas A&M University
2011	Top 10% paper award, 2011 IEEE Multimedia Signal Processing Workshop
2010	William Keeler Fellow Award, Texas A&M University
2008-2009	IEEE Circuits and Systems Society Distinguished Lecturer
2007	Award for Engineering Contributions, Texas A&M University
2006	*IEEE Signal Processing Magazine* best paper award
2003	Faculty Fellow Award, Texas A&M University
2002	Select Young Faculty Award, Texas A&M University
2001	Eugene Webb Faculty Fellow Award, Texas A&M University
2001	Office of Naval Research (ONR) Young Investigator Award
2000	Army Research Office (ARO) Young Investigator Award
1999	National Science Foundation (NSF) Career Award

PATENTS

1. B. Wang, Z. Xiong, D. Zhang, and H. Yu, "Bilateral denoising for digital camera images," US patent 9,275,438, filed March 2014, issued March 2016.
2. Z. Liu, V. Stankovic, and Z. Xiong, "Compress-forward coding with N-PSK modulation for the half-duplex Gaussian relay channel," US patent 8,363,747, filed March 2011, issued January 2013.
3. Q. Xu, V. Stankovic, and Z. Xiong, "Distributed source-channel coding of video using Raptor codes," US patent 8,315,306, filed September 2006, issued November 2012.
4. Y. Sun, A. Liveris, V. Stankovic, and Z. Xiong, "Source-channel approach to channel coding with side information," US patent 8,245,119, filed August 2011, issued August 2012.
5. Y. Yang and Z. Xiong, "Wyner-Ziv coding based on TCQ and LDPC codes," US patent 8,207,874, filed August 2008, issued June 2012.
6. Q. Xu, V. Stankovic, and Z. Xiong, "Layered Wyner-Ziv video coding for transmission over unreliable channels," US patent 8,073,052, filed July 2006, issued December 2011.
7. V. Stankovic, A. Liveris, Z. Xiong, and C. Georghiades, "Multi-source data encoding, transmission and decoding using Slepian-Wolf codes based on channel code partitioning," US patent 8,065,592, filed July 2010, issued November 2011.
8. Y. Sun, A. Liveris, V. Stankovic, and Z. Xiong, "Source-channel approach to channel coding with side information," US patent 8,020,082, filed March 2007, issued September 2011.
9. J. Xu, S. Li, Y. Zhang, and Z. Xiong, "Memory efficient 3-D wavelet transform for video coding without boundary effects," US patent 7,949,049, filed August 2004, issued May 2011.

10. Z. Liu, V. Stankovic, and Z. Xiong, "Compress-forward coding with N-PSK modulation for the half-duplex Gaussian relay channel," US patent 7,912,147, filed March 2006, issued March 2011.
11. V. Stankovic, A. Liveris, Z. Xiong, and C. Georghiades, "Multi-source data encoding, transmission and decoding using Slepian-Wolf codes based on channel code partitioning," US patent 7,779,326, filed March 2005, issued August 2010.
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TEACHING

1. ECEN 215: Principles of Electrical Engineering
2. ECEN 303: Random Signals and Systems
3. ECEN 314: Signals and Systems
4. ECEN 405: Electrical Engineering Design
5. ECEN 444: Digital Signal Processing
6. ECEN 642: Digital Image Processing & Computer Vision
7. ECEN 644: Advanced Digital Signal Processing
8. ECEN 646: Random Processes
9. ECEN 647: Information Theory
10. ECEN 649: Pattern Recognition
11. ECEN 663: Data Compression
12. ECEN 689: Network Information Theory and Coding